INTEGRATED EFFECTS OF N-P-K AND BIO-FERTILIZER ON THE GROWTH AND YIELD OF RAPESEED VARIETIES

Mir Noroz Khan Kulachi[1], Aurang Zaib Jamali[1], Abdul Waheed Solangi[1], Muhammad Ali Siyal[1], Zahid Ali Siyal[1] and Nazia Rais[1]

[1]Sindh Agriculture University, Tandojam-Pakistan, Corresponding author: jamali.zaib@gmail.com

ABSTRACT: *A field study was carried out to evaluate the integrated effects of N-P-K and Bio-fertilizer on the growth and yield of rapeseed varieties at Oilseeds Section, Agriculture Research Institute, Tandojam. The experiment was laid out in a three replicated randomized complete block design. Three treatments comprised in different levels of N-P-K + Bio-fertilizer (PGPR), (F_1 = 168-84-50 + 0 kg ha^{-1}, F_2 = 168-84-50 + 15 kg ha^{-1}, F_3 = 126-63-38 + 15 kg ha^{-1} and F_4 = 84-42-25 +15 kg ha^{-1}) and two rapeseed varieties (V_1 = Toria Selection and V_2 = Local). The statistical analysis of data showed that N-P-K + Bio-fertilizer in combination with each other caused significant ($P<0.05$) effect on growth and yield traits of rapeseed varieties as compared to application of N-P-K without Bio-fertilizer. In case of fertilizers, maximum number of branches plant^{-1} (12.2), days to flowering (80.5), plant height (93.2 cm), number of pods plant^{-1} (290.5), seed index: 1000-seed weight (6.2 g), seed yield (2150.0 kg ha^{-1}) and oil content (43.2 %) of rapeseed varieties were recorded in plots receiving N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1}, followed by plots fertilized with N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} and N-P-K + Bio-fertilizer @ 84-42-25 +15 kg ha^{-1} in all the growth and yield attributes, particularly seed yield (2060.0 and 1893.3 kg ha^{-1}), respectively. However, minimum seed yield (1683.3 kg ha^{-1}) was noted in N-P-K + Bio-fertilizer @ 168-84-50+0 kg ha^{-1}. Among rapeseed varieties, maximum number of branches per plant (9.4), days to flowering (77.8), plant height (89.7 cm), number of pods per plant (270.1), seed index: 1000-seed weight (5.3 g), seed yield (1970.0 kg ha^{-1}) and oil content (41.3 %) were observed in Toria selection, where minimum growth and yield traits, particularly seed yield (1923.3 kg ha^{-1}) was recorded in Local. Hence, it is concluded from the above results that application of N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} was found suitable and economical integration for obtaining optimum seed yied of rapeseed varieties due to having non-significant statistical differences with N-P-K + Bio-fertilizer @ 168-84-50 +15 kg ha^{-1} and N-P-K + Bio-fertilizer @ 126-63-38 +15 kg ha^{-1}.*

Keywords: Bio-fertilizer, Rapeseed, Varieties, Oil-content, Seed index and Yield traits.

INTRODUCTION

Rapeseed (*Brassica napus* L.) known as a rape and oilseed rape is grown primarily for its seed which yields about forty percent oil and a high-protein content [1]. Rapeseed oil generally contains a high level of erucic acid, which is mildly toxic to humans in large doses. Traditional and other uses have been for lamp oils, soap making, high-temperature and tenacious high-erucic acid lubricating oils, and plastics manufacturing [2]. Generally the soils are most deficient of essentially required macro and micronutrients as well as the soil organic matter. The soil organic matter is quite lower than the minimum requirement for desired crop yields. Hence, it is necessary to supply the soils with a package of nutrients comprised of N-P-K fertilizers as well as bio-fertilizers. [3] mentioned that N is most important macronutrient essentially needed for plant growth and it strongly stimulates growth, expansion of the crop canopy and interception of solar radiation. On the other hand, P is noted especially for its role in capturing and converting the sun's energy into useful plant compounds; while [4] stated that K is essentially required for plant growth and reproduction process. Although, development of high yielding crop cultivars is of great significance, but balancing nutrients by integration of inorganic and organic nutrients has become must to improve soil organic matter, so that the desired crop yields are achieved [5]. The application of bio-fertilizers in addition to inorganic N, P and K as well as other organic nutrient sources including farm yard manure has proved to be most beneficial practice to achieve high crop yields. Bio-fertilizers are important not only for the reduction in quantity of chemical fertilizers but also for getting better yield in sustainable agriculture [6]. Organic agriculture is a holistic production management system which promotes and enhances agro ecosystem, health, including biodiversity, biological cycles, and soil biological activity [7]. Bio-fertilizers are the alternate sources to meet the nutrient requirement of crops and to bridge the future gaps [8]. The bio-fertilized farming system is emphasized, bio-fertilizer, organic manuring and biocontrol of agricultural pests [9]. Bio-fertilizers are 100% natural and organic fertilizers that enrich the nutrient quality of soil [10]. The bacteria, fungi and blue-green algae (*cynobacteria*) are the main sources of bio-fertilizers [11]. Bio-fertilizers are the most advanced bio technology can increase the output, improve the quality and it is responsible for agriculture environment [12]. The applications of bio-fertilizers in agriculture are suggested as a sustainable way of increasing crop yields and economize their production as well [13]. Bio-fertilization is very safe for human, animal and environment to get lower pollution and saving fertilization cost. In addition, their application in soil improves soil biota and minimizes the sole use of chemical fertilizers [14]. Application of bio-fertilizers has been found effective to limit the use of mineral fertilizers, decreasing agricultural costs, maximizing crop yield by providing them with an available nutritive elements and growth promoting substances [15]. Soil microorganisms are important components in the natural soil sub-ecosystem because not only can they contribute to nutrient availability in the soil, but also bind soil particles into stable aggregates, which improve soil structure and reduce erosion potential [16]. [17] reported that increasing N level tended to decrease seed

oil content and increasing mineral nitrogen rate with bio-fertilizers significantly increased dry matter accumulation, LAI, stem diameter, head diameter, 1000-seed weight, seed yield and oil yield. [18] concluded that poultry manure and goat/sheep manure @ 6 tons ha^{-1} or @ 8 tons ha^{-1} replacing 75% or 50% NPK fertilizers, showed more promising results as compared to buffalo manure. Keeping this in view, the present study was undertaken to examine the integrated effects of N-P-K and Bio-fertilizer on the growth and yield of Rapeseed varieties.

METHODOLOGY

The field study was conducted at Oilseeds Section, Agriculture Research Institute of Tandojam Pakistan. The experiment was laid out in a three replicated randomized complete block design (RCBD), having net plot size 7 m x 5 m (35 m^2) and two treatment factors (A and B). The factor A four levels of N-P-K + Bio-fertilizer viz: F_1 = 168-84-50 + 0 kg ha^{-1}, F_2 = 168-84-50 + 15 kg ha^{-1}, F_3 = 126-63-38 + 15 kg ha^{-1}, F_4 = 84-42-25 + 15 kg ha^{-1} and factor B two varitiese of rapeseed crop V_1= Toria selection, and V_2= Local. The land was prepared by giving two dry plowings, followed by land leveling. After soaking dose and when land came in condition, the land was plowed with crosswise cultivator, followed rotavator and planking for a good seed bed preparation. The seed of rapeseed varieties was sown through single row hand drill. The fertilizers were applied as per treatments schedule. Nitrogen, Phosphorus and Potassium were applied in the form of Urea, DAP and SOP. Full dose of P and K and half dose of N was applied at the time of sowing whereas, remaining half of N was applied at the time of 1st irrigation. The bio-fertilizer (ferti-bio) contain Plant growth promoting Rhizobacteria (PGPR) was mixed with seed at the time of seed sowing.

Observations were recorded

The plant data were generated on parameters of economic importance such as, Number of branches per plant, Days to flowering, Plant height (cm), Number of pods per plant, Seed index (1000-seed weight, g), Seed yield (kg ha^{-1}) and Oil content (%) of oil seed crop rapeseed.

Statistical analysis: The collected data were subjected to statistical analysis using statistix 8.1 computer software [19]. The LSD test was applied to compare treatments superiority, where necessary.

RESULTS

The results are defined here by initially considering the effect of main factors (N-P-K + Bio-fertilizer and Varieties) individually and then describing their interactive effect on the growth and yield components.

Number of branches $plant^{-1}$

The results regarding number of branches per plant of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-1). It is obvious from the results that among fertilizer levels, maximum (12.2) number of branches per plant of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 11.3 and 7.0 number of branches per plant, whereas the minimum (6.2) number of branches per plant of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum (9.4) number of branches per plant was observed in Toria selection, while the minimum (8.9) number of branches per plant was noted in Local. In case of interaction, the maximum (12.7) number of branches per plant was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 +15 kg ha^{-1} x Toria selection, whereas minimum (6.0) number of branches per plant was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. Furthermore, the number of branhces per plant was non-significant (P>0.05) among fertilizer levels (F_2 and F_3).

Table-1. Number of branches $plant^{-1}$ of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	6.3	6.0	**6.2 B**
168-84-50 + 15 kg ha^{-1}	12.7	11.7	**12.2 A**
126-63-38 + 15 kg ha^{-1}	11.7	11.0	**11.3 A**
84-42-25 + 15 kg ha^{-1}	7.0	7.0	**7.0 B**
Mean	**9.4**	**8.9**	

Days to flowering

The results relating to days to flowering of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-2). It is evident from the data that among fertilizer levels, maximum (80.5) days to flowering of rapeseed varieties was noted under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 78.5 and 77.2 number of days to flowering, whereas the minimum (73.0) number of days to flowering of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum (77.8) number of days to flowering was observed in Toria selection, while the minimum (76.8) number of days to flowering was noted in Local. In case of interaction, the maximum (81.0) number of days to flowering was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50

+ 15 kg ha^{-1} x Toria selection, whereas minimum (72.0) number of days to flowering per plant was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. In addition, the number of days to flowering was non-significant (P>0.05) among fertilizer levels (F_2 and F_3).

Table-2. Days to flowering of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	74.0	72.0	**73.0 C**
168-84-50 + 15 kg ha^{-1}	81.0	80.0	**80.5 A**
126-63-38 + 15 kg ha^{-1}	79.0	78.0	**78.5 AB**
84-42-25 + 15 kg ha^{-1}	77.3	77.0	**77.2 B**
Mean	**77.8**	**76.8**	

Plant height (cm)

The results regarding plant height (cm) of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-3). It is depicted from the results that among fertilizer levels, maximum plant height (93.2 cm) of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 90.7 and 86.8 cm plant height, whereas the minimum plant height (84.2 cm) of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum plant height (89.7 cm) was observed in Toria selection, while the minimum plant height (87.8 cm) was noted in Local. In case of interaction, the maximum plant height (94.3 cm) was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} x Toria selection, whereas minimum plant height (82.7 cm) was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. Furthermore, the plant height was non-significant (P>0.05) among fertilizer levels F_3 and F_2.

Table-3. Plant height (cm) of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	85.7	82.7	**84.2 C**
168-84-50 + 15 kg ha^{-1}	94.3	92.0	**93.2 A**
126-63-38 + 15 kg ha^{-1}	91.3	90.0	**90.7 A**
84-42-25 + 15 kg ha^{-1}	87.3	86.3	**86.8 B**
Mean	**89.7**	**87.8**	

Number of pods plant^{-1}

The results relating to number of pods per plant of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-4). It is obvious from the results that among fertilizer levels, maximum (290.5) number of pods per plant of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 282.5 and 229.7 number of pods per plant, whereas the minimum (228.5) number of pods per plant of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum (270.1) number of pods per plant was observed in Toria selection, while the minimum (264.2) number of pods per plant was noted in Local. In case of interaction, the maximum (294.0) number of pods per plant was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} x Toria selection, whereas minimum (225.7) number of pods per plant was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. Furthermore, the number of branhces per plant was non-significant (P>0.05) among fertilizer levels F_3 and F_2.

Table-4.Number of pods plant^{-1} of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	231.3	225.7	**228.5 B**
168-84-50 + 15 kg ha^{-1}	294.0	287.0	**290.5 A**
126-63-38 + 15 kg ha^{-1}	285.0	280.0	**282.5 A**
84-42-25 + 15 kg ha^{-1}	234.3	225.0	**229.7 B**
Mean	**270.1**	**264.2**	

Seed index (1000-seed weight, g)

The results regarding seed index (1000-seed weight, g) of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-5). It is clear from the data that among fertilizer levels, maximum seed index: 1000-seed weight (6.2 g) of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 5.7 and 4.5 g seed

index (1000-seed weight), whereas the minimum seed index: 1000-seed weight (3.8 g) of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum seed index: 1000-seed weight (5.3 g) was observed in Toria selection, while the minimum (4.8 g) seed index (1000-seed weight) was noted in Local. In case of interaction, the maximum (6.3 g) seed index (1000-seed weight, g) was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} x Toria selection, whereas minimum (3.7 g) seed index (1000-seed weight) was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. Moreover, the seed index (1000-seed weight, g) was non-significant ($P>0.05$) among fertilizer levels F_3 and F_2.

Table-5. Seed index (1000-seed weight, g) of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	4.0	3.7	**3.8 B**
168-84-50 + 15 kg ha^{-1}	6.3	6.0	**6.2 A**
126-63-38 + 15 kg ha^{-1}	6.0	5.3	**5.7 A**
84-42-25 + 15 kg ha^{-1}	4.7	4.3	**4.5 B**
Mean	**5.3**	**4.8**	

Seed yield (kg ha^{-1})

The results pertaining to seed yield (kg ha^{-1}) of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-6). It is evident from the results that among fertilizer levels, maximum seed yield (2150.0 kg ha^{-1}) of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 2060.0 and 1893.3 kg ha^{-1} seed yield, whereas the minimum seed yield (1683.3 kg ha^{-1}) of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum seed yield (1970.0 kg ha^{-1}) was observed in Toria selection, while the minimum seed yield (1923.3 kg ha^{-1}) was noted in Local. In case of interaction, the maximum seed yield (2200 kg ha^{-1}) was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} x Toria selection, whereas minimum seed yield (1667 kg ha^{-1}) was seen under the interaction of N-P-K + Biofertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. Furthermore, the seed yield (kg ha^{-1}) was non-significant ($P>0.05$) among fertilizer levels F_3 and F_2.

Table-6. Seed yield (kg ha^{-1}) of rapeseed under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 + 0 kg ha^{-1}	1700	1667	**1683.3 C**
168-84-50 + 15 kg ha^{-1}	2200	2100	**2150.0 A**
126-63-38 + 15 kg ha^{-1}	2080	2040	**2060.0 A**
84-42-25 + 15 kg ha^{-1}	1900	1887	**1893.3 B**
Mean	**1970.0**	**1923.3**	

Oil content (%)

The data relating to oil content (%) of rapeseed varieties as affected by integrated application of N-P-K and Bio-fertilizer are presented in (Table-7). It is clear from the results that among fertilizer levels, maximum oil content (43.2%) of rapeseed varieties was recorded under the application of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} (F_2) followed by N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} (F_3) and N-P-K + Bio-fertilizer @ 84-42-25 + 15 kg ha^{-1} (F_4) with 41.7 and 40.0% oil content, whereas the minimum oil content (38.5%) of rapeseed varieties was noted under N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} (F_1). As regards rapeseed varieties, maximum oil content (41.3%) was observed in Toria selection, while the minimum oil content (40.3%) was noted in Local. In case of interaction, the maximum oil content (44.0%) was recorded under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1} x Toria selection, whereas minimum oil content (38.0%) was seen under the interaction of N-P-K + Bio-fertilizer @ 168-84-50 + 0 kg ha^{-1} x Local. In addition, the oil content (%) was non-significant ($P>0.05$) among fertilizer levels F_3 and F_2.

Table-7. Oil content (%) of rapeseed varieties under the integrated effect of N-P-K and Bio-fertilizer.

N-P-K levels + Bio-fertilizer	Rapeseed varieties		Mean
	Toria selection	Local	
168-84-50 +0 kg ha^{-1}	39.0	38.0	**38.5 C**
168-84-50 +15 kg ha^{-1}	44.0	42.3	**43.2 A**
126-63-38 +15 kg ha^{-1}	42.0	41.3	**41.7 AB**
84-42-25 +15 kg ha^{-1}	40.3	39.7	**40.0 BC**
Mean	**41.3**	**40.3**	

DISCUSSION

The main cause of reduced yield of rapeseed crop than its yield potential is lack of production technology, particularly imbalanced use of fertilizers. Rapeseed responds positively to management factors and overall yield is correlated with nutrient uptake throughout its growth period. Nutrients uptake begins soon after germination of rapeseed seedlings. An uptake of these nutrient elements is in low amounts at early stage of planting but as the plants continues to grow their need for the nutrient raises. Phosphorus and nitrogen that help improving germination of root system and vegetation are major nutrients but the necessity of some other trace elements is also as important as macro as they also contribute in several metabolic processes and are critical for plants survival. The soil organic matter is quite lower than the minimum requirement for desired crop yields. Hence, it is necessary to supply the soils with a package of nutrients comprised of NPK fertilizers as well as Bio-fertilizers. [3] mentioned that N is most important macronutrient essentially needed for plant growth and it strongly stimulates growth, expansion of the crop canopy and interception of solar radiation. On the other hand, P is noted especially for its role in capturing and converting the sun's energy into useful plant compounds; while [4] stated that K is essentially required for plant growth and reproduction process. The application of Bio-fertilizers in addition to inorganic N, P and K as well as other organic nutrient sources including farm yard manure has proved to be most beneficial practice to achieve high crop yields. Bio-fertilizers are important not only for the reduction in quantity of chemical fertilizers but also for getting better yield in sustainable agriculture [6]. Bio-fertilizers are the alternate sources to meet the nutrient requirement of crops and to bridge the future gaps [8]. The Bio-fertilized farming system is emphasized, Bio-fertilizer, organic manuring and biocontrol of agricultural pests (Saber, 1998). Bio-fertilizers are 100% natural and organic fertilizers that enrich the nutrient quality of soil [10]. The bacteria, fungi and blue-green algae (cynobacteria) are the main sources of bio-fertilizers [11]. Bio-fertilizers are the most advanced bio technology can increase the output, improve the quality and it is responsible for agriculture environment [12]. The applications of Bio-fertilizers in agriculture are suggested as a sustainable way of increasing crop yields and economize their production as well [13]. The study showed the effectiveness of Bio-fertilizer for improving growth and yield of rapeseed varieties in conjuction with recommended dose of N-P-K fertilizer. In case of fertilizers, maximum number of branches per plant (12.2), days to flowering (80.5), plant height (93.2 cm), number of pods per plant (290.5), seed index: 1000-seed weight (6.2 g), seed yield (2150.0 kg ha^{-1}) and oil content (43.2 %) of rapeseed varieties were recorded in plots receiving N-P-K + Bio-fertilizer @ 168-84-50 + 15 kg ha^{-1}, followed by plots fertilized receivng N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} with 11.3 number of branches per plant, 78.5 days to flowering, 90.7 cm plant height, 282.5 number of pods per plant, 5.7 g seed index: 1000-seed weight, 2060.0 kg ha^{-1} seed yield and 41.7 % oil content. Among rapeseed varieties, maximum number of branches per plant (9.4), days to flowering (77.8), plant height (89.7 cm), number of pods per plant (270.1), seed index: 1000-seed weight (5.3 g), seed yield (1970.0 kg ha^{-1}) and oil content (41.3 %) were observed in Toria selection. As regards interactive effects, maximum number of branches per plant (12.7), days to flowering (81.0), plant height (94.3 cm), number of pods $plant^{-1}$ (294.0), seed index: 1000-seed weight (6.3 g), seed yield (2200 kg ha^{-1}) and oil content (44.0 %) were recorded in the interaction of N-P-K + Bio-fertilizer @ 168-84-50 +15 kg ha^{-1} x Toria selection. The results of this research are in agreement with the findings of [20] who reported that increasing N level tended to decrease seed oil content and increasing mineral nitrogen rate with Bio-fertilizers significantly increased dry matter accumulation, LAI, stem diameter, head diameter, 1000-seed weight, seed yield and oil yield. Similarly, [5] reported that Application of up to 10 t FYM + 30 kg N and 20 kg P_2O_5 ha^{-1} significantly increased plant height, dry matter accumulation, number of primary and secondary branches, number of silique per plant, number of seeds per silique and seed yield over the control. Harvest index was not affected significantly by FYM + N and P. In another study, [21] revealed that fertilizer treatments had significant effects on growth and yield parameters viz. plant spread, numbers of leaves per plant, head diameter, main head weight and weight of secondary shoot per plant of *Brassica oleracea*. The results are also in line with those of [22] who studied the response of canola to Bio-frtilization using *Azotobacter chroococcum* as free living nitrogen fixing bacteria and *Bacillus megatherium* as phosphate dissolving bacteria (PDB) in new cultivated sandy soil. The data revealed to the almost importance of engaging bio-fertilization with organic manure in unified bio-organic treatment. The order of strain influences on crop yield and bacterial count arranged as follows mixed treatment with both microorganisms gave the highest response followed by single treatment with *Azotobacter chroococcum* or *Bacillus m egatherium* but the lowest effects were recorded in the control. The results are also supported by [23] who studied effects of nitrogen at different levels and Bio-fertilizers on growth and yield of canola in Qazvin province. The results showed that nitrogen had significant effect on the seed number per silques, number of silques per plant, seed yield, 1000 seed weight, seed yield and Plant height. So that with the increased use of nitrogen fertilizer, all of these traits increased and the combined use of was also increased on seed yield.

CONCLUSION

The results concluded application of Bio-fertilizer in integration with N-P-K significantly affected the growth and yield parameters of rapeseed varieties. The integrated application of Bio-fertilizer with higher rates of N-P-K produced maximum values for seed yield, but the application of N-P-K + Bio-fertilizer @ 126-63-38 + 15 kg ha^{-1} was found suitable and economical for obtaining optimum seed yield of rapeseed varieties due to having non-significant statistical differences with integration of bio fertilizer with higher rates of N-P-K.

REFERENCES

[1]Bayer, 2010. Bayer Sequence Genome of Canola. Bayer Crop Science: The Bio-energy Site, Retrieved 8th November,2010.

[2]Weiss, E. A. 1983. Oilseed crops. Pp. 161-215. Longman Group Limited. Pp-26.

[3]Don Eckert. 2010. Efficient fertilizer use of nitrogen. Book. Pp. 1-19.

[4]Bob Thompson. 2010. Efficient Fertilizer Use – otassium, Book. Pp. 1-13.

[5]Javaid, A., A. Tehmina and R. Bajwa, 2002. EM and VAM technology in Pakistan XII: Growth, nodulation and VA mycorrhizal response of *Phaseolus vulgaris* (L.) to long-term EM application. Pak. J. Phytopathol., 14 (1): 57-61.

[6]Karmakar, S., C. Lague, J. Agnew and H. Landry. 2007. Integrated decision support system (DSS) for manure management. Rev. Persp. Comp. Electro. Agri., 57: 190-201.

[7]Samman, S., J.W.Y. Chow, M.J. Foster, Z.I. Ahmad, J.L. Phuyal and P. Petocz, 2008. Fatty acid composition of edible oils derived from certified organic and conventional agricultural methods. Food Chem., 109: 670-674.

[8]Jeyabal, A., M.M. Rao, S.P. Palaniappan and S. Chelliah. 2000. Efficacy of foliar applied specialty fertilizers on growth and yield of sunflower. Res. Crops, 1 (3): 330-333.

[9]Saber, M.S.M. 1998. Prospective of sustainable farming through microbial biofertilization of plant rhizosphere. 8th Int. Sym. on Microbial Ecology, Halifax, Canada Pp- 23-28.

[10]Galal, Y.G.M., I.A. El-Ghandour, S.S. Aly, S. Soliman and A. Gadalla, 2000. Non-isotopic method for the quantification of biological nitrogen fixation and wheat production under field conditions. Biol. Ferti. Soils, 32 (1): 47-51.

[11]Victor, T.J. and R. Reuben, 2000. Effects of organic and inorganic fertilizers on mosquito populations in rice fields of southern India. Med. Vet. Entomol., 14 (4): 361-368.

[12]Kumar, V., A. Chandra and G. Singh. 2010. Efficacy of fly-ash based bio-fertilizers vs perfected chemical fertilizers in wheat (*Triticum aestivum*). Int. J. Engg., Sci., Technol., 2 (7): 31-35.

[13]Wali, A.M.A. 2010. The combined effect of mineral organic and bio-fertilizers on the productivity and quality of some wheat cultivars. Ph.D. Thesis, Fac. Agri. Alex. Univ., Egypt.

[14]Sabashini H.D., S. Malarvannan and P. Kumar, 2007. Effect of biofertilizers on yield of rice cultivars in Pondicherry, India. Asian J. Agri. Res., 1 (3): 146-150.

[15]Metin, T.A., G.B. Medine, C.C. Ramazan, O.F. Taskin and D. Sahin. 2010. The effect of PGPR strain on wheat yield and quality parameters. Proceeding of World Congress of Soil Science, Soil Solutions for a Changing World, 1–6 August 2010, Brisbane, Australia. Pp 215-219.

[16]Shetty, K.G., M.K. Banks, B.A. Hetrick and A.P. Schwab, 1994. Biological characterization of a southeast Kansas mining site. Water Air Soil Pollut., 78: 169-177.

[17]Mohamed, A.A.E. 2003. Response of sunflower to phosphorine and cerealine in inoculation under low NP-fertilizer levels J. Agri. Res., Tanta Univ., 29 (2): 653-663.

[18]Chachar, A.R. 2012. Response of sunflower to conjunctive use of organic manures and inorganic NPK fertilizers. M.Sc. (Agronomy) Thesis submitted to Sindh Agriculture University Tandojam.

[19]Statistix. 2006. Statistix 8 user guide, version 1.0. Analytical Software, PO Box 12185, Tallahassee FL 32317 USA. Copyright © 2006 by Analytical Software.

[20]Naseri, R., A. Maleki, H. Naserirad, S. Shebibi and A. Omidian. 2013. Effect of plant growth promoting rhizobacteria (PGPR) on reduction nitrogen fertilizer application in rapeseed (*Brassica napus* L.). Middle-East J. Sci. Res., 14 (2): 213-220.

[21]Moniruzzaman, M., S.N. Mozumder and M.R. Islam. 2008. Effects of sulfur, boron, zinc and molybdenum on yield and profitability of broccoli (*Brassica oleracea* L.) Var. italica). J Agri. Rural Dev., 6 (1&2): 55-61.

[22]Abd El-Gawad, A.M., M.H. Hendawey and H.I.A. Farag. 2009. Interaction between biofertilization and canola genotypes in relation to some biochemical constituents under Siwa Oasis conditions. R es. J. Agri. B iol. Sci., 5(1): 82-96.

[23]Naderifar, M. and J. Daneshian. 2012. Effect of different nitrogen and biofertilizers effect on growth and yield of *Brassica napus* (L.). Int. J. Agri. Crop Sci., 4 (8): 478-482.