Influence of nutrients management on growth and yield of Gobhisarson (*Brassica napus spp. napus*) under mid hill region of Himachal Pradesh

ABSTRACT

An experiment was conducted at KrishiVigyanKendr, Kangra, Himachal Pradesh to studty the response of nitrogen (N), phosphorus (P) and potassium (K) fertilizer as well as their combinations with farm yard manure, secondary and micronutrient application on growth and yield of *gobhisarson* during *rabi* 2019-20. The experiment consists of eleven treatments which replicated thrice under Randamized block design (RBD). Results of the experiment revealed that yield attributes like plant height, number of primary and secondary branches per plant, number of siliquae per plant, number of seeds per siliqua,and1000 seed weight were maximum in 150 per cent NPK was applied and minimum control. Seed and stover yield of mustard was significantly influenced with fertilizer application. Application of 150 per cent NPK resulted in significantly higher seed yield, stover yield as well as biological yield of *gobhisarson.* Yield responses to fertilization were ranked as NPK>NP>NK>PK, illustrating that N was the most limiting nutrient in rapeseed productivity following P and K. The seed yield (1451.2$kgha^{-1}$)and stover yield (2815.7 $kgha^{-1}$) increased progressively and significantly with 150% NPK application over recommended fertilizer dose followed by application of 100 per cent NPK in combination with farmyard manure (FYM)堆肥.

Introduction

Rapeseed(*typographical error*) is a member of *Brassicaceae* family which evolved to be one of the most significant oilseed crops in the world (Liu et al., 2022). With 12 per cent of the global output, India ranks third among rapeseed-mustard producers, behind China and Canada. Rapeseed is an important source of vegetable oil and bio fuel for the world (Zheng et al., 2022). In India total area under rapeseed & mustard cultivation was 6856.27 (000 ha) while total production was 10210 (000 tones) and productivity was 1524 $kgha^{-1}$ in India. In Himachal Pradesh rapeseed & mustard cultivation area was 8.28 (000 ha) with total production of 6.76 (0

00 tones) and productivity was 817 kg/ha $kgha^{-1}$(Indiastat, 2022). During 2018-19, among nine majorly grown oilseed crops rapeseed-mustard accounts for 23.2 per cent of the acreage and 26.2 per cent of the production. Although, rapeseed-mustard is cultivated in majority of states of the country, bulk of the production comes from Rajasthan (44.97 per cent), Haryana (12.44 per cent), Madhya Pradesh (11.32 per cent) Uttar Pradesh (10.60 per cent) and West Bengal (7.53 per cent) (Kumar et al 2022).

A variety of environmental variables, such as weather, cultivar, soil type, residual fertility, soil moisture, and soil nutrient concentration, influence the yield as well as of rape seed production (Kachel et al., 2019). Rapeseed-mustard crops are an effective match for the rainfed cropping approach since they have a minimal water demand and less chance of crop failure (Singh et al 2022). Under marginal and sub-marginal lands lack of proper nutrition is one of the reasons for low yield (Basumotary et al., 2020). To confront the difficulties of achieving a quantum increase in yield while also decreasing yield loss due to biotic and abiotic stresses to meet worldwide demand, agronomic practices along with the new technologies play a greater role (Shiferaw et al 2013). Fertilization of rapeseed and mustard with nitrogen, phosphate, and potassium is essential for the growth and development of rapeseed mustard crops (Geng et al., 2020). Among the essential nutrients, nitrogen is an important primary plant nutrient and a critical contributor in production (Ladha et al., 2020). Phosphorus plays an important part in many physiological processes as well as constituent element of nucleoproteins (Abbas et al., 2021). Potassium is essential for energy transmission, stress resistance, osmoregulation, and stomatal movement (Hasanuzzaman, 2018). Sulphur also plays an important role in oilseed crops as its deficiency could negatively affect NPK fertiliser uptake and effectiveness that lead to decreased agricultural yield and quality (Chahal et al., 2020; Patel et al., 2009; Kumar et al., 2011). Zn is a structural component of several enzymes and essential for enzyme activation. Zn deficiency adversely affects carbohydrate metabolism, negatively impacts pollen structure, and reduces yield (Pandey et al., 2006; Fang et al., 2008).

Therefore substantial increase in crop yield and oil content of the crop could be achieved by application of appropriate dose of NPK fertilizers along with proper dose of secondary and micro nutrients (Tripathi et al 2010). The use of fertiliser in modern agro-management techniques is essential for increasing crop growth and productivity (Singh et al., 2019). Fertilizers are reported to increase productivity of the cropping systems when applied with farmyard manure (Rehman et al., 2020). Nowadays farmers are relaying on intensive farming with heavy chemical fertilizer where over use of chemical fertilizers have been associated with decline in soil physical, chemical and biological properties and ultimately reducing the crop yield. Therefore, it is very important to identify the proper nutrient dose as well as their effective combination with appropriate proportion. Keeping this in view, present investigation was carried out to find out best fertilizer application combinations as well as management for maximisation of gobhisarson production.

Materials and Methods

The experiment was carried out during *rabi* 2019-20 at the experimental farm, SAREC, KVK, Kangra, Himachal Pradesh situated at 32°09´ N latitude, 76^{0}22'E longitude and at an altitude of 733m from the mean sea level. The total rainfall received during the entire growing seasons amounted to 517.7 mm (Figure 1). The experiment was laid out in a Randomized Block Design (RBD) consists of 11 treatments which was replicated thrice. Prior to sowing, the field site was ploughed three times approximately 30 cm deep using a power tiller and fine seed beds were prepared prior to sowing. The gobhisarson variety GSC-7 was sown at a spacing of 30 cm × 15 cm between rows and plants. Intercultivation, thinning and weeding were carried out as and when required. The trial was irrigated on need basis. Full dose of phosphorus and potassium and 1/3rd of nitrogen was band placed according to the treatment just prior sowing. The remaining nitrogen was top dressed in two equal splits. Growth parameters viz, plant height, dry matter accumulation, number of primary and secondary branches were recorded from each plot. Five randomly selected plants in each plot were tagged for various periodic observations. Observations on yield attributes and yield of mustard were recorded. Number of seeds per siliqua was recorded from average of 25 randomly collected siliquae in each treatment. The grain and stover yield of each net plot was recorded separately as kg plot^{-1} and then converted into kg ha^{-1}. Collected data were analyzed by using the Fisher's analysis of variance (ANOVA) techniques and treatments' means were compared using least significance difference (LSD) test at 5% probability level (Stigler., 2008)

Results and Discussion

Growth studies

Plant height

The plant height is a crucial physical characteristic linked to vegetative development (Table 1). Plant height is often used in order to monitor how various treatments are affecting crop development. Application of fertilizers significantly enhanced the vegetative growth of the over zero fertilizer application. Plant height increased at a very slow rate up to 60 DAS. After succeeding 60 days, a sharp and linear increase in the plant height was recorded up to 150 DAS. Thereafter, a negligible increment in the plant height was observed. Plant height at 30 DAS was not affected significantly by different treatments. At 60 DAS and thereafter, plant height was significantly affected by different doses of inorganic fertilizers and FYM applications. However, application of 150 per cent NPK recorded significantly high plant height over 100 per cent NPK throughout the crop duration. Application of zinc sulphate along with the recommended dose of fertilizer was at par with 100% NPK +S @35 kg ha^{-1}, 100% NPK+ B @ 1 kg ha^{-1} and 100% NPK at all stages. Among skip fertilizer treatments, application of 100% NP and 100% NK recorded significantly high plant height over 100% PK. SPNF treated plots were observed significantly taller plants over control throughout the crop duration except 30 and 60 DAS. This improvement in plant height due to fertilizer application might be attributed to the role of NPK in cell division and expansion. The results are in conformity with those already reported by Indira et al., 2021.

Number of primary branches

Primary branches at 30 and 60 DAS were not affected significantly by different treatments. However, the branches were started to appear prominently after 60 DAS to 150 DAS (Table2). Application of 150 per cent NPK had the most branches which were significantly high over recommended fertilizer dose at all stages except 30 and 60 DAS. Application of 100% NPK + FYM 22.5 t ha^{-1} was in consistent with the 150 per cent NPK at 120, 150 DAS as well as at harvest. Application of 100% NPK + $ZnSO_4$ @ 25 kg ha^{-1} and 100% NPK + S @35 kg ha^{-1} were in line with 100 per cent NPK except at 60 and 90 DAS and numerically higher than application of 100% NPK + B @1kg ha^{-1}. Sher et al. (2019) reported that maximum number of primary branches of canola were recorded when NPK was applied as compared to control.

Number of secondary branches

Application of recommended dose of fertilizer significantly enhanced branching in *Gobhisarson* over control at all stages (Table 2). Enhanced branching was brought by application of 150% NPK which was significantly high over 100% NPK at all stages. Application of 150% NPK was at par with 100% NPK + FYM @ 2.5 t ha^{-1} but both were significantly high over recommended dose. Application of 100% NPK + S @35 kg ha^{-1} was in line with of 100% NPK + $ZnSO_4$ @ 25 kg ha^{-1}, 100% NPK + B @1kg ha^{-1} as well as 100% NPK. Application of 100% NP, 100% NK and 100% PK significantly more branching over control but numerically lesser than the recommended fertilizer dose. The current results are in line with the findings of Ali, 2008 and Indira et al., 2021.

Dry matter accumulation

There was no discernible variation in dry matter accumulation was recorded at 30 and 60 DAS owing to fertiliser application (Table 1). At 90, 120, 150 DAS as well as harvest, application of 100% NPK recorded significantly high dry matter accumulation over control which was further enhanced by application of 150 per cent NPK. However, application of 150 per cent NPK was in line with 100% NPK applied along with FYM @ 2.5 t ha^{-1} but both were significantly high over recommended fertilizer dose. Application of 100% NPK + $ZnSO_4$ @ 25 kg ha^{-1} was found at par with 100% NPK + S @35 kg ha^{-1}, 100% NPK + B @1 kg ha^{-1} as well as 100% NPK at all stages. However application of FYM along with RDF was also in line with $ZnSO_4$ treatment except 30 and 90 DAS. Skipping of any one primary nutrient reduced the branching in *Gobhisarson*. Dry matter accumulation in SPNF administered plots was significantly high over control. Application of fertilizer enhanced cell multiplication, elongation, expansion and imparts a deep green colour to leaves due to better chlorophyll synthesis, which in turn increases the effective area for photosynthesis, resulting in relatively greater amount of dry matter accumulation (Meena et al., 2021; Karthika et al., 2018; Osman et al., 2013)

Yield attributes

Plant population

Plant population did not show any significant effect due to nutrient management treatments in *Gobhisarson*. However, numerically higher plant population was recorded in 150% NPK (24.7 m^{-2}) as well as in treatment 100% NPK + FYM @ 2.5 t ha^{-1} (24.4 m^{-2}).The control treatment recorded the lowest plant population. (Table 3)

Number of siliquae per plant

Application of 150% NPK (316.5) recorded significantly more number of siliquae over 100% NPK (261.4). However, application of 100 per cent NPK in combination with FYM @ 2.5 t ha^{-1} also recorded significantly high number of siliquae over recommended dose but less than 150 per cent NPK (Table 3). Application of 100% NPK+S @ 35 kg ha^{-1} was at par with 100% NPK +Zn@ 25 kg $ZnSO_4$, 100% NPK + B @1kg ha^{-1} as well as 100% NPK. Skipping any one primary nutrient from the recommended dose resulted in a significant reduction in siliquae count over balanced fertilizer application. Eventually, application of 100% PK recorded significantly low siliquae count over 100% NP and 100% NK. The marked improvement in number of siliquae per plant with the application of 150% NPK which might be due to its profound influence in enhancing branching which might have facilitated greater flowers formation. The current results are in line with the findings of Gupta et al 2021 and Hasan, 2016.

Number of seeds per siliqua

Application of 100% NPK recorded 24.3 seeds per siliqua which was significantly enhanced by application of 150% NPK (25.7) (Table 3).Application of of 100% NPK along with farm yard manure (24.3) was recorded significantly greater values over 100% NPK + S @ 35 kg ha $^{-1}$(24.3), 100% NPK +Zn@ 25 kg $ZnSO_4$(24.0), 100% NPK + B @1kg ha^{-1}(24.3). Sulfur application along with recommended dose was found at par with treatments consists of ZnSO4 and B. Among skip fertilizer treatments application of 100% NP and 100% NK recorded significantly more number of seeds per siliquae as compared to 100% PK. Furthermore, following SPNF practice in gobhisarson enhance the seed count significantly over control. Plant well supplied with fertilizers have relatively larger photosynthesizing area, consequently accumulating higher quantities of photosynthates which will be translocated to sink site that is pods and seeds (Anjum et al., 2012)

1000 seed weight

Application of recommended dose of chemical fertilizers improved the 1000 seed weight of gobhisarson over no fertilizers application. Eventually, application of 100% NPK recorded test weight of 3.41g which was significantly increased by application of 150% NPK (3.61g). Application of 150 % NPK was at par with 100% NPK+FYM @ 2.5 t ha^{-1} (3.55g), 100% NPK+S @35 kg ha^{-1} (3.49g) and 100% NPK+Zn @ 25 kg $ZnSO_4$ (3.46g). Application of 100% NP (3.37g) and 100% NK (3.36g) recorded significantly high test weight over 100% PK (3.13g). Plots consist of SPNF practice recorded substantially greater test weight over control.

Yield

Seed yield

Application of 100% NPK recorded 1259.3 kgha^{-1} of seed yield which was significantly increased by increase in fertility level to 150% NPK (1451.2 kgha^{-1}), application of 100% NPK+FYM @2.5t ha^{-1} (1421.0 kgha^{-1}), 100% NPK+$ZnSO_4$ (1408.6 kgha^{-1}) and 100% NPK+B@ 1kgha^{-1} (1358.3

kgha^{-1}) (Table 4).Application of 100% NPK+S@35 kgha^{-1} was at par with application of 100 % NPK+$ZnSO_4$@25 kgha^{-1}(1408.6 kgha^{-1}).This may be due to provision of macro and micro nutrients at latter stages which might have improved accumulation of assimilate in seeds and thus resulting in heavier seed. The results of this investigation are in consonance with the findings of Ramya et al. (2022). As compared to 100% NPK, skipped application of any primary nutrient significantly decreased the *Gobhisarson* seed yield. Eventually, application of 100 %NP (1189.3 kgha^{-1}) recorded yield at par with the application of 100%NK (1129.7 kgha^{-1}) which were significantly more than 100% PK (794.4 kgha^{-1}). In SPNF plots *Gobhisarson* yield was significantly more than control by 39.82 % and significantly less by 37.20 % than 100%NPK. However,intercropped with pea provided additional yield of 264.4 kgha^{-1}. Thus, *Gobhisarson* equivalent yield in SPNF plot was statistically on par with 100%NPK. Plant well supplied with fertilizers have relatively larger photosynthesizing area, consequently accumulating higher quantities of photosynthates which will be translocated to sink site that is pods and seeds (Anjum et al., 2012) The increase in yield with NPK application might have been the results of increased branch number per plant, siliques number per plant, seed number per silique and thousand-seed weight (Zangan et al., 2021)

Stover yield

Application of 100%NPK recorded 2519 kgha^{-1} of stover yield which was significantly increased by increasing fertility level to 150% NPK (2815.7 kgha^{-1}), application of 100% NPK + FYM@2.5t ha^{-1} (2801.8 kgha^{-1}), 100% NPK+$ZnSO_4$ (2816.9 kgha^{-1}) and 100% NPK+B@1 kgha^{-1} (2717.2 kgha^{-1}) (Fig 2).Application of 100% NPK+S@35 kgha^{-1} was at par with application of 100 %NPK+$ZnSO_4$ @ 25 kgha^{-1}(2816.9 kgha^{-1}). As compared to 100% NPK application, skipped application of any primary nutrient significantly decreased the *Gobhisarson*stover yield. Eventually, application of 100 % NP (2381.4 kgha^{-1}) recorded yield at par with the application of 100 % NK (2291.7 kgha^{-1}) which were significantly high over 100 % PK (1584.1 kgha^{-1}). In SPNF plots *Gobhisarson*stover yield (2113.0 kgha^{-1}) was significantly more than control by 49.7 % and significantly less by 16.1 % than 100% NPK.Intercropped pea provided additional yield of 264.4 kgha^{-1}. Thus, *Gobhisarson* equivalent yield in SPNF plot was statistically on par with 100% NPK.

Biological Yield

Application of fertilizers significantly improved the biomass of *Gobhisarson* over control. The treatment with maximum yield attributes recorded highest seed yield and stover yield (Fig 2). Application of 150% NPK (4266.9 kgha^{-1}) recorded significantly high biological yield over 100% NPK (3779.2 kgha^{-1})which was at par with 100% NPK +Zn@25 kgha^{-1} $ZnSO_4$ (4225.6 kg ha^{-1}), 100% NPK + FYM @ 2.5 t ha^{-1}(4222.8 kgha^{-1}), 100%NPK + B @1kg ha^{-1}(4075.5 kg ha^{-1}) and 100% NPK +S @35 kg ha^{-1} (4048.5 kg ha^{-1}). Skipping of any one primary nutrient reduced the biomass of *Gobhisarson* by 5.83%, 10.45% and 58.9% (100% NP, 100% NK and 100% PK respectively.) as compared to the application of 100% NPK. SPNF treatment recorded biomass yield of 2904.2 kgha^{-1} which was significantly more as compared to control (1537.8 kgha^{-1}) and less as compared to 100% NPK application (3779.2 kgha^{-1}). The equivalent biomass yield obtained from intercropping pea was 3562.7 kg ha^{-1} found to be at par with 100 % NP (3570.7 kg ha^{-1}), 100 % NK (3421.4 kg ha^{-1}) as well as 100% NPK (3779.2 kg ha^{-1}). Biological yield also increased due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by high dose of fertilizer application. The results are in close conformity with that of Mondal et al., (2017) Rehman et al., 2022, and Yao et al., (2022).

Harvest Index

Effect of different nutrient management treatments were non-significant on harvest index of *Gobhisarson*.

Conclusion

Repeated and imbalanced applications of chemical fertilizers is ecologically unsound that leads to reduction in productivity and profitability of rapeseed crops. Eco-friendly and economically feasible strategies like integration of inorganic fertilizer FYM, macro and micro nutrients is the better option for balance nutrition of the rapeseed crop. Application of increased fertilizer amount over reccamended dose enhanced the yield of gobhisarson. Application of Zn, B and S fertilizers with NPK fertilizer can help to increase the yield and yield components in rapeseed.

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Table1. **Influence of nutrients management on plant height and drymatter accumulation in gobhisarson**

Treatment	Plant height (cm)						Dry matter accumulation (g $plant^{-1}$)					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**Harvest**
T_1- Control	10.8	34.1	129.4	154.7	161.3	162.7	0.6	1.2	5.5	20.2	28.9	26.9
T_2-100%PK	13.3	43.0	136.3	167.4	174.3	175.2	0.7	1.5	5.6	21.6	29.9	26.9
T_3-100% NPK	18.6	68.3	158.6	182.3	190.3	191.4	0.7	1.6	7.2	25.9	35.6	34.6
T_4-150% NPK	19.4	78.0	173.2	194.3	198.7	199.4	0.8	1.9	9.1	29.1	40.2	38.2
T_5-100% NPK +S @35 kg ha^{-1}	17.8	74.0	161.3	185.1	192.3	192.3	0.8	1.5	7.2	26.1	36.7	35.3
T_6-100% NPK +Zn@ 25 kg $ZnSO_4$	16.7	73.0	164.5	187.3	193.0	192.7	0.7	1.6	7.4	26.8	37.3	36.3
T_7-100% NPK + B @1kg ha^{-1}	16.9	69.0	160.3	183.9	192.7	191.2	0.6	1.6	7.3	25.7	35.3	34.8
T_8-100% NPK + FYM @ 2.5 t ha^{-1}	18.4	76.1	169.4	189.7	194.6	195.1	0.5	1.7	8.8	27.8	38.6	36.6
T_9-100 % NP	17.8	56.1	148.0	178.0	182.3	184.3	0.6	1.3	7.1	24.7	34.3	32.3
T_{10}-100 % NK	17.7	56.4	146.0	175.8	183.4	184.6	0.6	1.4	7.0	23.7	32.6	31.6
T_{11}-SPNF (*Gobhisarson* + Pea)	16.3	59.3	151.7	178.3	185.2	186.3	0.7	1.3	5.8	22.2	33.1	30.1
SE(m ±)	0.6	1.21	1.63	1.91	1.96	1.78	0.4	0.1	0.23	0.32	0.67	0.57
CD (P=0.05%)	NS	3.64	4.90	5.73	5.91	5.46	NS	NS	0.74	1.13	2.08	1.77

Table2. **Influence of nutrients management on Primary branches and Secondary branches in gobhisarson**

Treatment	Primary branches plant^{-1}						Secondary branches plant^{-1}					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**Harvest**
T_1- Control	0	0.4	0.6	1.3	1.4	1.4	0	0	0.8	1.1	1.2	1.2
T_2-100%PK	0	0.6	1.1	3.1	3.2	3.2	0	0	1.3	2.1	2.3	2.3
T_3-100% NPK	0	0.7	1.6	3.6	3.8	3.8	0	0	1.5	3.4	3.5	3.5
T_4-150% NPK	0	1.3	2.1	4.3	4.5	4.5	0	0	2.1	4.2	4.3	4.3
T_5-100% NPK +S @35 kg ha^{-1}	0	0.8	1.8	3.4	3.6	3.6	0	0	1.6	3.6	3.7	3.7
T_6-100% NPK +Zn@ 25 kg $ZnSO_4$	0	0.7	1.7	3.5	3.6	3.6	0	0	1.8	3.5	3.6	3.6
T_7-100% NPK + B @1kg ha^{-1}	0	0.7	1.9	3.2	3.3	3.3	0	0	1.7	3.4	3.4	3.4
T_8-100% NPK + FYM @ 2.5 t ha^{-1}	0	0.9	1.9	4.1	4.3	4.3	0	0	2.0	3.9	4.1	4.1
T_9-100 % NP	0	0.7	1.4	3.2	3.3	3.3	0	0	1.3	3.2	3.4	3.4
T_{10}-100 % NK	0	0.6	1.2	3.1	3.3	3.3	0	0	1.2	3.2	3.3	3.3
T_{11}-SPNF (*Gobhisarson* + Pea)	0	0.6	1.3	3.2	3.3	3.3	0	0	1.4	3.3	3.4	3.4
SE(m ±)	-	0.01	0.02	0.07	0.12	0.13	-	-	0.06	0.08	0.06	0.07
CD (P=0.05%)	-	NS	0.10	0.22	0.36	0.42	-	-	0.19	0.27	0.24	0.24

Table 3.Influence of nutrients management on yield attributes ofgobhisarson

Treatment	Number of plants m^{-2}	Number of siliquae $plant^{-1}$	Number of seeds $siliqua^{-1}$	1000 seed weight (g)
T_1- Control	20.2	94.3	20.2	3.07
T_2-100 % PK	22.7	148.2	22.4	3.13
T_3-100% NPK	22.3	261.4	24.3	3.41
T_4-150% NPK	24.7	316.5	25.7	3.61
T_5-100% NPK +S @35 kg ha^{-1}	22.4	270.3	24.3	3.49
T_6-100% NPK +Zn@ 25 kg $ZnSO_4$	23.4	262.7	24.0	3.46
T_7-100% NPK + B @1kg ha^{-1}	23.6	269.5	24.3	3.42
T_8-100% NPK + FYM @ 2.5 t ha^{-1}	24.4	290.6	24.8	3.55
T_9-100 % NP	23.0	218.4	23.1	3.37
T_{10}-100 % NK	22.8	199.8	23.3	3.36
T_{11}-SPNF (*Gobhisarson* + Pea)	22.8	152.6	22.3	3.37
SE(m ±)	0.82	3.81	0.12	0.05
CD (P=0.05%)	NS	11.32	0.37	0.17

Table4. Influence of nutrients management on seed yield, stover yield, biological yield and harvest index ofgobhisarson

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index
T_1- Control	476.7	1061.1	1537.8	0.31
T_2-100 % PK	794.4	1584.1	2378.4	0.33
T_3-100% NPK	1259.3	2519.8	3779.2	0.33
T_4-150% NPK	1451.2	2815.7	4266.9	0.34
T_5-100% NPK +S @35 kg ha^{-1}	**1348.3**	2700.2	4048.5	0.33
T_6-100% NPK +Zn@ 25 kg $ZnSO_4$	1408.6	2816.9	4225.6	0.33
T_7-100% NPK + B @1kg ha^{-1}	1358.3	2717.2	4075.5	0.33
T_8-100% NPK + FYM @ 2.5 t ha^{-1}	1421.0	2801.8	4222.8	0.34
T_9-100 % NP	1189.3	2381.4	3570.7	0.33
T_{10}-100 % NK	1129.7	2291.7	3421.4	0.33
T_{11}-SPNF (*Gobhisarson* + Pea)	791.2 + 264.4 (1271.4)*	2113.0 + 541.5 (2291.3)*	2904.2 (3562.7)*	0.33 (0.27)
SE(m ±)	26.2 (32.28)*	26.2 (32.28)	74.3 (98.04)*	0.10
CD (P=0.05%)	78.6 (95.22)*	78.6 (95.22)	223.6 (289.2)*	NS

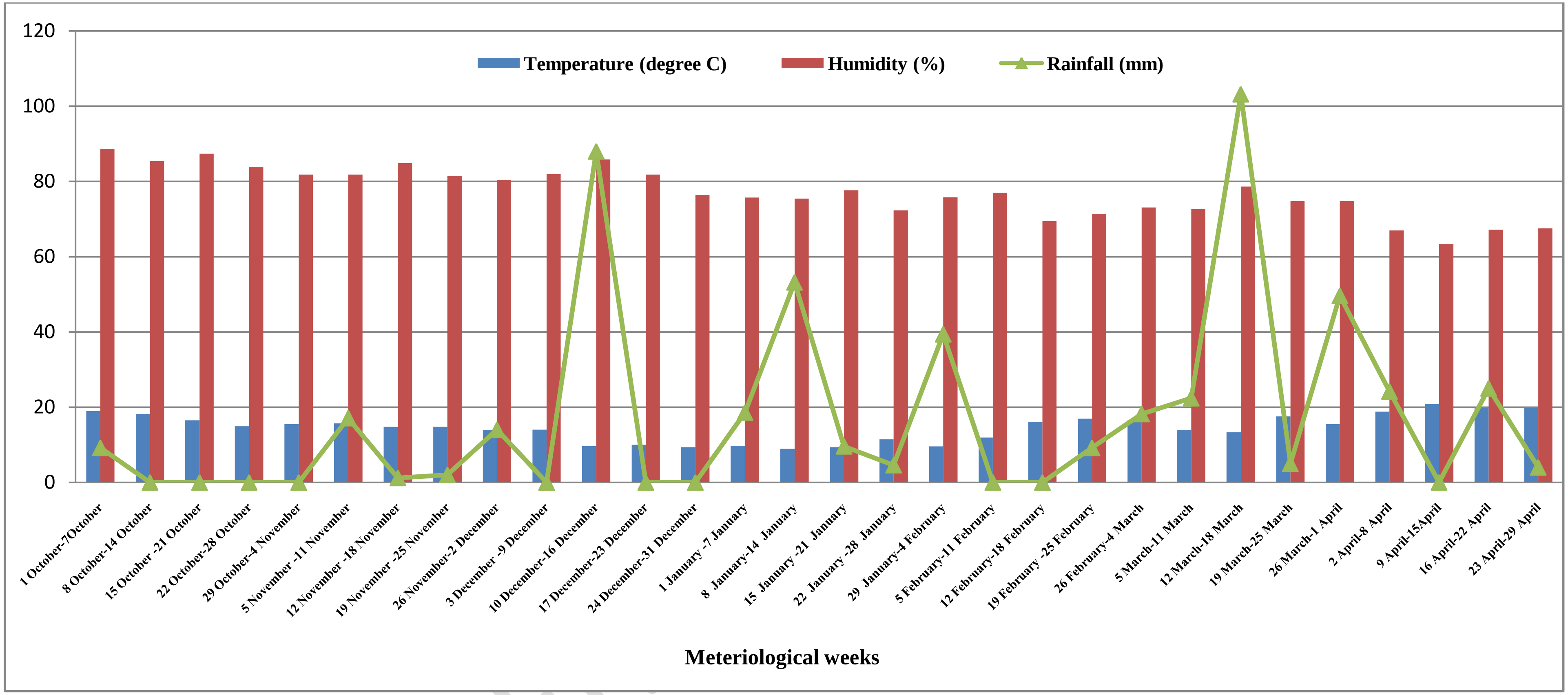

Figure 1. Metereological observation of Kangra during the crop growing season

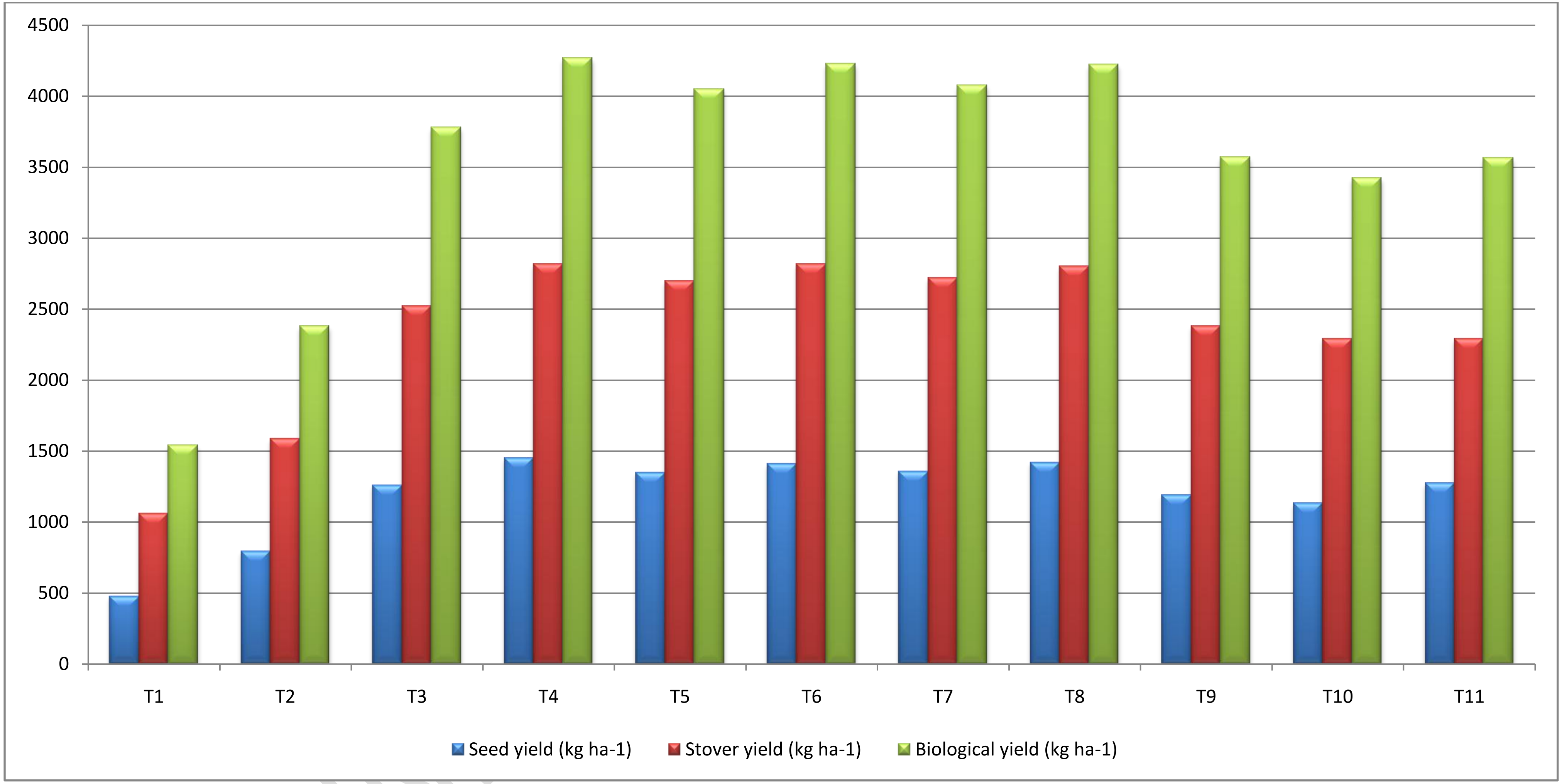

Figure 2.Influence of nutrients management on seed yield, stover yield, and biological yield of gobhisarson