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THE EFFECT OF SEEDING DENSITY AND POTASSIUM RATES ON GROWTH AND YIELD OF PSYLLIUM SEED (*Plantago ovata*)

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ABSTRACT

The study was conducted on psyllium seed to assess the combine effect of seeding density and potassium rates on growth, productivity and yield. A factorial study was carried out in Randomized Complete Block Design (RCBD), during winter season of 2020-21, at Tobacco and Medicinal Crop Research Institute, Tandojam. The seeding densities were maintained at 6.5, 7.5 and 8.5 kg ha^{-1}. Whereas potassium was applied @ 0, 20, 40, 60, 80 and 100 kg ha^{-1}. The data were recorded for various quantitative, qualitative and yield parameters. The results shown that all quantitative parameters had non-significant effect of various potassium levels and seeding density except plants m^{-2}. The values of plants m^{-2} were observed higher at potassium level 100 kg ha^{-1} and seeding density level of 8.5 kg ha^{-1}. While the qualitative parameters had significant differences due to various potassium levels and seeding density, excludes days to 50% spike emergence, days to 50% maturity and seed index. The seed weight $spike^{-1}$ (g), seed index (g) and seed yield (kg ha^{-1}) were observed maximum from the plants where potash was applied at 100 kg ha^{-1}. In qualitative parameters, the seeding density at 7.5 kg ha^{-1}observed higher seed yield (1152.33 kg ha^{-1}). While higher seed weight $spike^{-1}$ (0.14g) observed at seeding density 6.5 kg ha^{-1}. Among growth parameter, leaf area was increased at potash level 60 kg ha^{-1} and the values of seeding density showed higher leaf area at seeding density level 8.5 kg ha^{-1}. The same pattern showed of leaf area index where seeding density was higher at seeding density 8.5 kg ha^{-1}. Leaf area duration and total dry matter were found significantly higher at potash level 100 kg ha^{-1} and seeding density 8.5 kg ha^{-1}. While the net assimilation rate was greater at seeding density level 8.5 kg ha^{-1}. It is concluded from the results that and seeding density 7.5 kg ha^{-1} and increased levels of potassium at 100 kg ha^{-1} had ensure better results for most quantitative, qualitative and yield attributes.

Keywords: seeding density, potassium rate, psyllium seed

INTRODUCTION

Plantago ovata is an important medicinal plant belonging to the family Plantaginaceae. *Plantago ovata* is native to Iran, India, Afghanistan, Pakistan and east of Mediterranean, regions of northern Africa. India is the biggest producer and main exporter of Plantago ovata seeds (Zahoor *et al*., 2004). Psyllium is produced mainly for its mucilage content obtained from seeds. The use of mucilage is to overcome chronic diarrhea. It is also proved that psyllium husk significantly reduced the body weight and overcome issue of obesity among children adolescents. It also reduces the cholesterol level in body which ultimately reduces the risk of cardiovascular disease, Akram *et al.* (2019). Psyllium is a rabi season crop and the desirable climate during its growing period is cold and dry, which enhances its seed yield quantitatively and qualitatively. This crop needs moderate fertilizer and irrigation use. The crop depends largely on temperature, solar radiation, moisture and soil fertility for their growth and nutritional requirements. Plant population may affect the maximum availability and utilization of these factors. It is necessary to determine the optimum density of plant population per unit area for obtaining maximum yields (Baloch *et al*., 2002). Potash plays an important role on plant density. Plants can be protected by lodging at its maturity due to potash effect, at that time plant possess many ear heads on tillers and branches. Potassium (K) is

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one of the vital elements required for plant growth and physiology. Under drought stress conditions, K regulates stomata opening and helps plants adopt water deficits (Hasanuzzaman *et al*., 2018). The biological function of K, its uptake, its translocation, and its role in plant abiotic stress tolerance (Wang *et al*., 2013). Psyllium seeds are imported from neighboring countries for the use of local industry, which may cause increase expenditure. The growers have minimum use of N and P fertilizers in the field and are not applying K in the field, so the meager amount of work has been conducted on potash effect on Psyllium seed at environmental conditions of Tandojam. The present study is therefore designed to evaluate the effect of planting density and potassium rates on growth and yield of psyllium seed.

MATERIALS AND METHODS

The study was conducted at Tobacco and Medicinal Crop Research Institute, Tandojam during the year 2020-21, to investigate the efficacy of seeding density and various Potassium levels on growth and yield of psyllium seed. The experiment was laid out in Randomized Complete Block Design with three blocks. The psyllium seeds were sown on 15^{th} of November, 2020 by maintaining the seeding density at 6.5, 7.5 and 8.5 kg ha^{-1}. Whereas Potassium as Sulphate of Potash was applied at the rate of 20, 40, 60, 80 and 100 kg ha^{-1}. The unfertilized experimental units were treated as control. The experiment was run in factorial Randomized Complete Block Design (RCBD) with three blocks. The experimental soil was Typic Camborthid, silty clay loam in texture and calcareous in nature. The average maximum and minimum temperatures, relative humidity and pan evaporation rate recorded during the course of study were: 33.21 ºC and 11.53 ºC, 47.33% and 4.93 mm, respectively. Before sowing of the seeds, the land was prepared thoroughly. The land was ploughed crosswise with a five-share plough followed by levelling. After soaking dose, when the soil came in condition then again soil was ploughed by gobble (Disc harrow), then rotavator used to well soil tilth. At the final soil preparation, a half dose of Nitrogen and a full dose of Phosphorus was applied. While the remaining half dose of Nitrogen was applied at the time of second irrigation. Whereas Potassium was applied as per the treatment plan. The data were recorded for quantitative parameters [Plants m^{-2}, Plant height (cm), Tillers $plant^{-1}$, Spikes $plant^{-1}$, Seeds $spike^{-1}$], qualitative parameters [Days to 50% spike emergence, Days to 50% maturity, Seed weight $spike^{-1}$ (g), Seed index (g),Seed yield (kg ha^{-1})] and growth parameters [Leaf area (LA) (cm^2), Leaf area index (LAI), Leaf area duration (LAD) (days), Total dry matter (TDM) (g m^{-2}), Crop growth rate (CGR) (g m^{-2} day^{-1}), Net assimilation rate (NAR) (g m^{-2} day^{-1})]. Five plants from each treatment plots were selected randomly for recording of observations on: plant height, tillers $plant^{-1}$, spikes $plant^{-1}$, seeds $spike^{-1}$ and leaf area were taken fortnightly. While, days to 50% spike emergence and days to 50% maturity were taken on growth stages. Seed index was calculated by 1000 grain weight in each plot.

After 30 days of sowing destructive sampling were done by harvesting plants at ground level from 100 cm row length in each plot with 15-days interval. Fresh weight was recorded and a sub sample (20g) was taken to calculate the dry weight and converted into m^{-2}. A sub sample of fresh weight was placed in oven for 48 hours at 65ºC. For calculating leaf area plant was taken and measured by leaf area meter and image J software (Bakr, 2005). Following growth related parameters were recorded.

LAI (Leaf area index)

It is the ratio of total leaf area to land area. A sub sample (10 g) of green laminae will be used to measure leaf area using leaf area meter (LI-3100C).

$$LAI = \frac{\text{Leaf area}}{\text{Land area}}$$

CGR (Crop growth rate) (g m^{-2} d^{-1})

Crop growth rate (CGR) would be calculated as suggested by Hunt (1978).

$$CGR = \frac{W_2 - W_1}{t_2 - t_1}$$

W_1 and W_2 are total dry weights harvested at time t_1 and t_2, respectively.

LAD (Leaf area duration) (days)

Leaf area duration (LAD) would be estimated according to the method of Hunt (1978).

$$LAD = \frac{(LAI_1 + LAI_2)\,(t_2 - t_1)}{2}$$

Where LAI_1 and LAI_2 are the leaf area indices at time t_1 and t_2, respectively.

NAR (Net assimilation rate) (g m^{-2} d^{-1})

The average net assimilation rate (NAR) would be calculated by using the formula of Hunt (1978).

$$NAR = \frac{TDM}{LAD}$$

TDM= Total dry matter, and LAD= Leaf area duration

The crop data were processed for the analysis of variance (ANOVA) using a software Statistics 8.1 (Statistix, 2006). The least significant difference (LSD) test was applied to compare the treatment superiority for all the parameters all the 5% level of probability.

RESULTS AND DISCUSSION

The results of quantitative parameters included plant height, tillers plant^{-1}, spikes plant^{-1} and seeds spike^{-1} were observed non-significant in response to the seeding density and various potassium levels (Table 1). Whereas plants m^{-2} was significant (294.63) at potassium level 100 kg ha^{-1} and observed maximum (309.47) at seeding density of 8.5 kg ha^{-1}. The result regarding plant height was found similar by Soomro (2004), while the results of tillers plant^{-1} are in agreement with Moosavi *et al.* (2012). Salimath *et al*. (2019) conducted field trial evaluated the yield paramaters in which seeds spike^{-1} (71.79) were similar to the results as 71.29 at 40 kg ha^{-1}. The qualitative parameters (Table 2) had significant differences due to various Potassium levels and seeding density. The days to spike emergence, maturity and seed index were observed non-significant in response to the seeding density.

Table 1. Quantitative parameters of Psyllium seed (*Plantago ovata*) as affected by potassium levels and seeding density

Potassium levels (Kg ha^{-1})					
kg ha^{-1}	**Plants m^{-2}**	**Plant height (cm)**	**Tillers plant^{-1}**	**Spikes plant^{-1}**	**Seeds spike^{-1}**
K_1= Control (0)	240.98b	30.62	3.33	12.53	57.51
K_2= 20	278.01a	30.58	2.84	15.71	70.49
K_3= 40	270.25ab	30.24	3.40	16.87	71.29
K_4= 60	280.11a	31.50	3.33	17.98	65.16
K_5= 80	288.69a	31.45	3.22	18.22	75.24
K_6= 100	294.63a	31.30	3.58	19.58	77.13
SE±	16.592	0.854	0.608	3.213	7.260
$LSD_{0.05\%}$	33.719	Ns	Ns	Ns	Ns
Seeding density (D) (Kg ha^{-1})					
D_1 = 6.5	246.56b	30.54	3.40	16.38	73.11
D_2 = 7.5	270.30b	30.90	3.12	16.29	65.57
D_3= 8.5	309.47a	31.41	3.33	17.78	69.73
SE±	11.732	0.604	0.430	2.272	5.134
$LSD_{0.05\%}$	23.84	Ns	Ns	Ns	Ns

Table 2. Qualitative parameters of Psyllium seed (*Plantago ovata*) as affected by potassium levels and seeding density

Potassium levels (K) (Kg ha^{-1})					
kg ha^{-1}	**Days to 50% spike emergence**	**Days to 50% maturity**	**Seed weight spike^{-1} (g)**	**Seed index (g)**	**Seed yield (kg ha^{-1})**
K_1= Control (0)	73.33a	119.67a	0.10c	1.40c	782.9d
K_2= 20	72.67ab	118.33ab	0.11bc	1.45bc	880.0cd
K_3= 40	71.78bc	116.56bc	0.12ab	1.45bc	912.6bc
K_4= 60	70.89cd	114.78cd	0.12ab	1.45c	955.3abc
K_5= 80	70.00d	113.00d	0.13a	1.51ab	1009.9ab
K_6= 100	68.22e	109.44e	0.13a	1.59a	1039.25a
SE±	0.659	1.319	8.723	0.039	61.78
$LSD_{0.05\%}$	1.341	2.682	0.017	0.080	125.55
Seeding density (D) (Kg ha^{-1})					
D_1 = 6.5	71.56	116.11	0.14a	1.47	704.93c
D_2 = 7.5	71.06	115.11	0.12b	1.48	1152.33a
D_3= 8.5	70.83	114.67	0.11b	1.47	932.7b
SE±	0.466	0.933	6.168	0.028	43.686
$LSD_{0.05\%}$	Ns	Ns	0.012	Ns	88.780

Table 3. Growth parameters of Psyllium seed (*Plantago ovata*) as a response of potassium levels and seeding density

kg ha^{-1}	Potassium levels (K) (Kg ha^{-1})					
	Leaf area (cm^2)	**Leaf area index (LAI)**	**Leaf area duration (LAD) (days)**	**Total dry matter (TDM) g m^{-2}**	**Crop growth rate (CGR) g m^{-1} day^{-1}**	**Net assimila-tion rate (NAR) g m^{-2} day^{-1}**
K_1= Control (0)	3.37c	1.99	50.51b	290.25d	3.93	5.58
K_2= 20	4.69b	2.29	51.59b	313.74cd	4.25	5.27
K_3= 40	5.19ab	2.07	55.92ab	341.77cd	4.25	5.49
K_4= 60	5.64a	1.84	67.63a	385.92bc	4.26	7.02
K_5= 80	5.56a	2.45	68.7a	463.69b	4.44	6.50
K_6= 100	5.37a	2.13	68.75a	567.15a	4.41	6.48
SE±	0.323	0.236	6.92	46.17	0.557	0.948
$LSD_{0.05\%}$	0.656	Ns	14.07	93.839	Ns	Ns
Seeding density (D) (kg ha^{-1})_						
D_1 = 6.5	4.75b	2.11b	60.00ab	138.08c	4.56	2.42c
D_2 = 7.5	4.17c	1.74c	54.40b	365.33b	4.04	6.18b
D_3= 8.5	5.99a	2.54a	67.16a	677.85a	4.17	9.57a
SE±	0.228	0.167	4.89	32.651	0.393	0.670
LSD0.05%	0.464	0.339	9.953	66.354	Ns	1.362

The days to 50% spike emergence (68.22) and maturity (109.44) were observed earlier as compared to control where potash was applied at the rate of 100 kg ha^{-1}. At the same rate of potash, seed weight spike^{-1} (0.13g), seed index (1.59g) and seed yield (1039.25 kg ha^{-1}) were observed maximum as compared to rest of the treatments. While to compare seeding density, seed weight spike^{-1} (0.14g) was observed higher at seeding density 6.5 kg ha^{-1} and seed yield ha^{-1} (1152.33 kg) was observed maximum where seeding density was maintained at 7.5 kg ha^{-1}. These outcomes are in occurrence with the Soomro (2004) and observed maximum seed yield (906 kg ha^{-1}) under seeding density 7.5 kg ha^{-1}. Amanullah *et al.* (2016) had found greater seed yield (1250 kg ha^{-1}) at high seeding density which were very close to these results. Among the growth parameters (Table 3), each parameter was observed significant in response to the various potassium rates and seeding density except the crop growth rate (CGR). Each parameter was observed lower in control treatment as compared to rest of the treatments. LA was increased (5.64cm^2) at Potassium level 60 kg ha^{-1} and the values of seeding density shows higher LA (5.99) at seeding density level 8.5 kg ha^{-1}. The same pattern shows of LAI where seeding density was higher (2.54) at seeding density 8.5 kg ha^{-1}. LAD and TDM were found significantly higher at Potassium level 100 kg ha^{-1} and seeding density 8.5 kg ha^{-1}. While the NAR was greater (9.57) at seeding density level 8.5 kg ha^{-1}. Choudhary *et al*. (2014) obtained significant result of total dry matter (TDM) with the combine application of NPK.

CONCLUSION

Increased potassium rate @ 100 kg ha^{-1} and 80 kg ha^{-1} showed better result for all parameters. So, it needs to be further study on Potassium levels more than 100 kg ha^{-1} that might be give higher yield of Psyllium seed.

AUTHOR'S CONTRIBUTION

M. I. Majeedano: Conducted and manage the experiment and obtaining the data.

S. D. Majeedano: Managed the experimental field and performed necessary cultural practices.

Y. A. Majeedano: Analyzed data and provided technical inputs.

D. K. Khazada: Conducted review and literature for input in paper.

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