

2022 Final Report

From the

**Northeast Agriculture Research Foundation
and
Conservation Learning Centre**

Project Title: Faba bean yield and quality response to phosphorus fertilization



Principal Investigators:

Brianne McInnes¹ and Robin Lokken²

¹Northeast Agriculture Research Foundation, Melfort, SK

²Conservation Learning Centre, Prince Albert, SK

Project Identification

- 1. Project Title:** Faba bean yield and quality response to phosphorus fertilization
- 2. Project Number:** ADOPT20211071 (NARF) & ADOPT20211126 (CLC)
- 3. Producer Group Sponsoring the Project:** Northeast Agriculture Research Foundation (NARF) and the Conservation Learning Centre (CLC)
- 4. Project Location(s):** Melfort, SK (RM #428) and Prince Albert, SK (RM #461)
- 5. Project Start and End Dates (Month & Year):** March 17, 2022 to March 1, 2023
- 6. Project Contact Person & Contact Details:**

Brianne McInnes, Operations Manager
Northeast Agriculture Research Foundation (NARF)
PO Box 1240, Melfort, SK, S0E 1A0
Work: (306) 920-9393; Cell: (306) 231-8900; Email: neag.agro@gmail.com

Robin Lokken, General Manager
Conservation Learning Centre
PO Box 1903 Stn Main, Prince Albert, SK, S6V 6J9
Phone: (306) 960-1834; Email: info@conservationlearningcentre.com

Objectives and Rationale

- 7. Project Objectives:**

The objective of this project was to demonstrate the response of faba beans to increasing phosphorus rates in a seed-placement versus side-band placement.
- 8. Project Rationale:**

Faba beans are among the highest users of phosphorus for annual grain crops. A 50 bu/ac faba bean crop has been estimated to meet total removal rates of 89-108 lbs of P₂O₅/ac (SaskPulse). This far exceeds the seed-placed safe rate of 40lbs of P₂O₅/ac, along with the current recommendations for the same target yield. Past research has shown that faba beans are very responsive to phosphorus fertilization by demonstrating increased seed yields (Turk et. al. 2022; Henry et. al. 1995; Holzapfel 2016 & 2017). The most recent work done by Chris Holzapfel in 2016 (ADOPT) and 2017 (SaskPulse) comparing placements and rates of phosphorus fertilizer demonstrated increased faba bean seed yields at up to 80 kg/ha of P₂O₅ when moisture was not limiting. Furthermore, Chris Holzapfel's work demonstrated that faba bean seed size was not affected by phosphorus application, whereas Turk et. al. 2022 also found that applying phosphorus significantly decreased the days to flower as compared to the control. When comparing faba bean sensitivity to placement of phosphorus fertilizer as well as response to phosphorus fertilization, Henry et. al. 1995 found that faba beans were the most responsive to phosphorus fertilization as compared to lentils and peas, and were least affected by placement. Chris Holzapfel's work with placement and rates also found faba bean establishment was not significantly affected by placement of P fertilizer (SaskPulse 2018).

Faba beans are very well suited to northern Saskatchewan due to their ability to withstand cooler weather and wetter conditions as compared to other main pulse crop options, such as peas and lentils. Furthermore, faba beans are not plagued by severe yield losses due to *Aphanomyces* root rot, and thus they are a great pulse crop option to diversify crop rotations. Because faba beans are so well adapted to northern climates and can survive prolonged wet periods, the potential for increased acreage in the thick black soil zone and northern areas is very probably; however, very little agronomic data has been collected on fertility responses in the area with newer high yielding varieties. Additionally, due to logistical reasons at seeding time many producers seed-place phosphorus fertilizer. The safe rate of seed-placed P₂O₅ in faba beans is currently 40 lbs/ac; however, faba beans have been found to withstand much higher levels of seed-placed P without demonstrating reductions in plant establishment (SaskPulse 2018). Knowing what placement is best when implementing high phosphorus fertilizer rates is important, so producers can ensure they don't risk diminishing plant emergence when placing high rates close to the seed. This demonstration will combine placement options and increased rates of phosphorus fertilizer in faba beans to demonstrate to producers the best options when managing their faba bean crop.

Literature Cited

Henry, J.L., Slinkard, A.E., and T.J. Hogg. 1995. The effect of phosphorus fertilizer on establishment, yield and quality of pea, lentil and faba bean. *Can. J. Plant. Sci.* 75 (2): 395-398.

"Phosphorus Response in Faba beans." 2018. Saskatchewan Pulse Growers: Pulse Research Summary. Available at: [191001 Phosphorus response in faba beans.pdf \(saskpulse.com\)](https://www.saskpulse.com/191001-Phosphorus-response-in-faba-beans.pdf)

Turk, Munir A., Tawaha, Abdel-Rahman M. 2002. Impact of seeding rate, seeding date, rate and method of phosphorus application in faba bean (*Vicia faba* L. minor) in the absence of moisture stress. *Biotechnol. Agron. Soc. Environ.* 6(3): 171-178.

Methodology and Results

9. Methodology:

The demonstration was conducted at two locations, which included Melfort and Prince Albert, SK in 2022. Both sites are located in the northern area of the black soil zone. The small-plot demonstration was arranged as a two-part factorial with phosphorus placement being the first factor and phosphorus rate being the second factor (Table 1). A no phosphorus control was included for comparison. The treatments were completely randomized with four replications at both locations.

Table 1. Treatments used in Faba bean yield and quality response to phosphorus fertilization at Melfort and Prince Albert, SK in 2022

Treatment #	Phosphorus Placement	Rate (kg P ₂ O ₅ /ha)
1	Control	0
2	Side-band	20
3		40
4		60

5		80
6		100
7	Seed-placed	20
8		40
9		60
10		80
11		100

Seeding equipment and crop management varied by location (Table 2). The variety of faba bean used was CDC Snowbird, which was seeded to target 45 plants/m² at both sites. The faba beans were seeded into wheat stubble on May 16th at Melfort and into oat stubble on May 18th at Prince Albert. Nitrogen was applied at 21 kg/ha at seeding time to be balanced across all treatment at Melfort, but not at Prince Albert. Total applied nitrogen varied based on nitrogen from the applied phosphorus source. Phosphorus was applied as per treatment as mono-ammonium phosphate (MAP) (11-52-0). Any other nutrients were to be applied based on soil sample results to be non-yield limiting (Table 3). Weeds, insects, and disease were controlled using registered products at each participating site at the discretion of each site manager for best management practices. All plots were harvested with a plot combine on September 22nd at Melfort and on September 27th at Prince Albert.

Table 2. Agronomic information and dates of operation for Faba bean yield and quality response to phosphorus fertilization at Melfort and Prince Albert, SK in 2022.

Factor/Operation	Melfort	Prince Albert
Previous Crop	Wheat	Oats
Pre-Emergent Weed Control	Glyphosate 540 @ 1L/ac	None
Variety	CDC Snowbird	CDC Snowbird
Seeding Date	May 16	May 18
Row Spacing (cm)	30.5	25.4
Plot size	14m ²	10.7m ²
Kg N-K₂O-S/ha (P2O₅ as per trt)	21-0-0	0-0-0 (N slightly varied based on applied 11-52-0 to meet trt P ₂ O ₅)
Pre-emergent herbicide	Bonanza 480EC @ 0.93L/ac May 12 & Glyphosate 540 @ 1L/ac May 21	None
Emergence Counts	June 8	June 9
Post-emergent herbicide	Viper ADV @ 0.4L/ac June 22	0.45L/ac Poast Ultra June 22
Days to Flower	July 11 & 12	July 13
Insecticide	Cygon 480 @ 380mL/ha August 8	None
Foliar Fungicide	Cotegra @ 280mL/ac July 12	None
Maturity	August 29 – September 6	August 29 – September 6
Pre-harvest Application	Glyphosate 540 @ 0.67L/ac Sept 7	Reglone Ion 2.04 L/ha September 16
Harvest Date	September 22	September 27

Table 3. Soil sample results for Faba bean yield and quality response to phosphorus fertilization at Melfort and Prince Albert, SK in 2022.

Depth	NO3-N (kg/ha)	Olsen-P (ppm)	K (ppm)	S (kg/ha)	pH	Organic Matter (%)	Salts (mmho/cm)
Melfort							
0-15cm	70	9	559	31	6.1	8.9	0.57
15-30cm	54			20	6.7		0.57
Prince Albert							
0-15cm	20	7	330	40	5.8	6.6	0.18
15-60cm	10			18	6.3		0.19

Data collection at all sites consisted of plant density (PPMS), days to flower (DTF), days to maturity (DTM), grain yield, thousand seed weights (TSW), and an economic analysis. Plant density was measured by counting the seedlings along two 1-meter sections of crop row per plot. The average between the two counted rows was then divided by the row spacing at each respective site to determine the plants/m² (PPMS). Days to flower (DTF) was determined by recording the day that the majority of plants within a plot began to flower. The seeding date was then subtracted from the flowering date to determine the days to flowering. Days to maturity (DTM) was noted by recording the day when 80% of pods in a plot had turned brown. This was then converted to the number of days from seeding that it took each plot to reach maturity. Grain yield was determined at each site by weighing each harvested plot sample and converting the grams per plot to a kg/ha equivalent, while correcting to a consistent moisture of 16%. Thousand seed weight (TSW) was determined by counting and weighing a minimum of 500 seeds per plot, and converting the weight into grams per 1000 seeds. Economic analysis was completed using spring fertilizer and seed pricing and winter 2023 commodity prices. Lastly, statistical analysis was completed for each site separately using randomized complete block in Statistix 10.

10. Results:

Environmental Conditions:

Throughout the 2022 growing season, both of the participating sites experienced slightly above average temperatures (+0.2-0.8°C) alongside below average to above average precipitation (Table 4). Melfort had above average precipitation at 102% of the long-term average (269.9mm) with an average growing season temperature of 15.1°C, which was an increase of 0.8°C from the long-term average. Prince Albert had below average precipitation at 82% of the long-term average (221.4mm) and an average growing season temperature of 15.2°C, which was a 0.2°C increase from the long-term average.

Table 4. Mean temperatures and precipitation collected from local weather stations at Melfort and Prince Albert, SK for May to September 2022.

	May	June	July	August	September	Average/Total
--Temperature(°C)--						
Melfort 2022^x	9.9	15.2	18.2	18.7	13.7	15.1

Long-term^x	10.7	15.9	17.5	16.8	10.8	14.3
Prince Albert 2022	10.5	15.5	18.3	18.5	13.3	15.2
Long-term^y	11.3	16.2	18.7	17.1	11.6	15.0
--Precipitation(mm)--						
Melfort 2022^x	90.8	78.1	34.9	36.5	29.6	269.9 (102%)
Long-term^x	42.9	54.3	76.7	52.4	38.7	265.0
Prince Albert 2022	17.9	75.7	63.7	37.8	26.3	221.4 (82%)
Long-term^y	39.4	79.7	77.0	44.6	29.0	269.7

^x 2022

Conditions and Long-Term Climate Normal from the nearest Environment Canada Weather Station. Long-term averages are from 1981-2010

^y Long-Term average is from the years 2012-2021

Plant Density (PPMS)

PPMS was only significant for placement at Prince Albert ($p=0.0476$). The significant affect of placement was that PPMS was greater when phosphorus was side-band (63.3 PPMS) as compared to seed-placed (56.9 PPMS). Although, placement in the seed-row resulted in significantly lower plant stands, the plant stand of this treatment was still very high as compared to the target density of 45 PPMS. This makes the difference in PPMS between placement options less concerning from an agronomic perspective. There was no significant effect of phosphorus rate at either site for PPMS. When comparing sites, average PPMS was much greater at Prince Albert (59.9 PPMS) as compared to Melfort (44.4 PPMS).

Days to Flower (DTF)

Days to Flower (DTF) was not significantly affected by rate or placement of phosphorus at either site (Table 6; Table 7). When comparing sites, average DTF were quite comparable at 56.1 days at Melfort and 56.0 days at Prince Albert.

Days to Maturity (DTM)

Days to Maturity (DTM) was not significantly affected by rate or placement of phosphorus at either site. At Prince Albert, DTM did tend to decrease as phosphorus rate increased, but the difference was not significant between rates. When comparing sites, average DTM was quite comparable at 108.6 days at Melfort and 107.2 days at Prince Albert.

Grain Yield

Grain Yield was only significant for rate at Prince Albert ($p=0.0327$). The significant affect of phosphorus rate was that yield increased linearly as phosphorus rate increased; however, yield was only significantly increased at 100 kg/ha as compared to the control. At Melfort yield was not affected by phosphorus rate, but when sites were combined, yield increased linearly up to 80 kg/ha of P_2O_5 (Figure 1). When comparing sites, average yields were much greater at Prince Albert (6683.0 kg/ha) as compared to Melfort (4176.5 kg/ha).

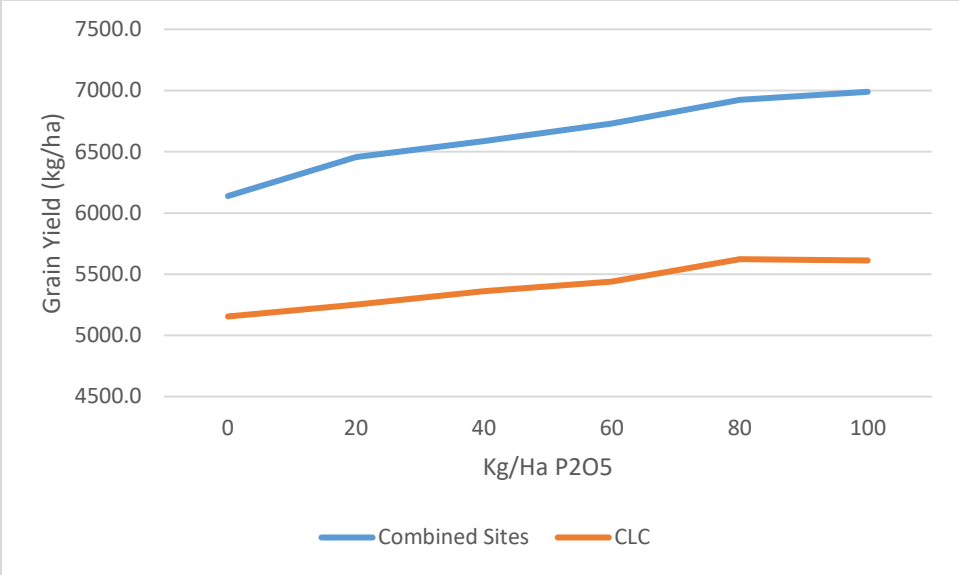


Figure 1. Effect of phosphorus rate on faba bean yield in Faba bean yield and quality response to phosphorus fertilization at Melfort and Prince Albert, SK in 2022.

Thousand Seed Weight (TSW)

TSW was not significant for phosphorus rate or placement at either site. At Melfort TSW tended to decline as phosphorus rate increased, but the difference was not significant. When comparing sites, average TSW was much greater at Prince Albert (477.0 g/1000 seeds) as compared to Melfort (383.9 g/1000 seeds). The much greater TSW at Prince Albert may in part have contributed to the greater average yield at this site as compared to Melfort.

Economic Analysis

The economics of this demonstration were assessed using spring 2022 retail prices for fertilizer as paid by the Northeast Agriculture Research Foundation and winter 2023 selling price of faba beans for feed. Based on the economic analysis faba beans were more profitable at Prince Albert as compared to Melfort in 2022 (Table 5). This was due to the higher average yields demonstrated at Prince Albert in 2022. At Melfort the greatest net profit occurred at a P₂O₅ rate of 80 kg/ha (+\$3.97/ha) as compared to the control. All other phosphorus rates had lower net profits as compared to this rate and the no P control. At Prince Albert, the greatest net profits occurred at the highest P₂O₅ rate of 100 kg/ha (+\$268.01/ha). This rate had a much greater net profit as compared to the control and all other treatments. At Prince Albert, net profits tended to increase linearly as P₂O₅ rate increased. Overall, applying high rates of P₂O₅ in faba beans increased marginal profits up to the highest P₂O₅ rate at Prince Albert, but only at 80 kg P₂O₅/ha at Melfort.

Table 5. Economic analysis for Faba bean yield and quality response to phosphorus fertilization at Melfort and Prince Albert, SK in 2022.

Site	Phos Rate	Cost of MAP ^z		Cost of Urea ^z		Yield Kg/Ha	Price ^y (\$/kg)	Marginal Profit ^x (\$/ha)	Net Profits ^u (\$/ha)
		\$/Tonne	\$/ha	\$/Tonne	\$/ha				
NARF	0kg/ha	1510	0.00	1360	62.56	4170.9	0.40	1589.12	0.00
	20kg/ha	1510	26.35	1360	50.32	4046.6	0.40	1525.79	-63.33

	40kg/ha	1510	52.70	1360	38.08	4134.3	0.40	1546.41	-42.71
	60kg/ha	1510	79.04	1360	24.48	4147.7	0.40	1538.96	-50.16
	80kg/ha	1510	105.39	1360	12.24	4320.0	0.40	1593.09	+3.97
	100kg/ha	1510	131.74	1360	0.00	4236.5	0.40	1545.91	-43.21
CLC	0kg/ha	1510	0.00	1360	62.56	6138.1	0.40	2368.13	0.00
	20kg/ha	1510	26.35	1360	50.32	6455.9	0.40	2479.87	+111.74
	40kg/ha	1510	52.70	1360	38.08	6585.8	0.40	2517.20	+149.07
	60kg/ha	1510	79.04	1360	24.48	6731.4	0.40	2562.11	+193.98
	80kg/ha	1510	105.39	1360	12.24	6924.9	0.40	2624.63	+256.50
	100kg/ha	1510	131.74	1360	0.00	6989.6	0.40	2636.14	+268.01

^zMay 2022 retail price as paid by the Northeast Agriculture Research Foundation

^ySelling price of faba beans for feed found on [Trade History | Agfinity Inc.](#)

^xMarginal profits only account for gross profit, and the treatment difference in the cost of MAP and the cost of Urea. It does not account for other variable and fixed expenses associated with the cost of production.

^uNet profits is the difference in treatment profitability as compared to the no phosphorus control

11. Conclusion and Recommendation:

Overall, phosphorus rate only had a significant affect on faba bean grain yield and phosphorus placement only had a significant affect on plant density in this demonstration. When placement was significant, seed-placed phosphorus reduced plant stands as compared to side-band phosphorus. When rate was significant, increasing phosphorus rates increase seed yields linearly up to 100 kg P₂O₅/ha. At Prince Albert, 100 kg/ha of phosphorus resulted in the greatest net profit, and at Melfort 80kg/ha was the only phosphorus rate that resulted in a greater net profit than the control.

Supporting Information:

12. Acknowledgements: This project was funded under the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership bi-lateral agreement between the federal government and the Saskatchewan Ministry of Agriculture. The Conservation Learning Centre and the Northeast Agriculture Research Foundation would like to express our gratitude to the Saskatchewan Ministry of Agriculture's ADOPT program for funding this demonstration and for providing signage. Thank you to all participating sites including the Conservation Learning Centre and the Northeast Agriculture Research Foundation staff for their hard work in completing this demonstration.

13. Extension:

There has been no extension of results on this project to date; however, both the Northeast Agriculture Research Foundation and Conservation Learning Centre will post the final report to their respective websites at www.neag.ca and www.conservationlearningcentre.com, and the results will be shared at winter events whenever possible. The CLC trial was toured by industry reps from Cargill and Lake Country Co-op.

14. Abstract and Summary:

Faba beans are a pulse crop that are very well suited to northern Saskatchewan due to their ability to withstand cooler weather and wetter conditions as compared to other main pulse crop options, such as peas and lentils. Faba beans are among the highest users of phosphorus for annual grain crops, with a 50 bu/ac Faba bean crop having estimated to meet total removal rates of 89-108 lbs of P_2O_5 /ac. The safe rate of seed-placed P_2O_5 in faba beans in Saskatchewan is currently 40 lbs/ac; however, faba beans have been found to withstand much higher levels of seed-placed P without demonstrating reductions in plant establishment (SaskPulse 2018). To demonstrate the response of faba beans to phosphorus rates and placement options a small-plot demonstration was conducted near Prince Albert and Melfort, SK in 2022. Placement of phosphorus was in the side-band or seed-row at 0, 20, 40, 60, 80 or 100 kg/ha of P_2O_5 . Treatments were completely randomized and replicated four times at each location. Data collection consisted of plant density (plants/m²), days to flowering, days to maturity, grain yield, thousand seed weights (TSW), and an economic analysis. When placement was significant, plant stands were significantly increased when phosphorus was placed in the side-band as compared to the seed-row. When phosphorus rate was significant yields increased linearly up to 100 kg/ha of phosphorus. When comparing the profitability of each treatment, 100 kg/ha of phosphorus resulted in the greatest net profits at Prince Albert, and 80kg/ha of phosphorus resulted in the greatest net profit at Melfort.

15. Appendices:

Table 6. Statistical analyses and treatment means for Faba bean yield and quality response to phosphorus (P) fertilization at Melfort, SK in 2022. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Melfort					
	Plant density ^z	Floweri ng ^z	Maturity ^z	Grain Yield ^z	TKW
	Plants/m ²	Days to	Days to	Kg/Ha	g/1000 seeds
P Rate (p-value)	0.8793	0.7723	0.2716	0.0991	0.1509
P Placement (p-value)	0.2683	0.0712	0.8327	0.9177	0.8301
Place * Rate (p-value)	0.7432	0.6140	0.0902	0.4464	0.5590
Grand Mean	44.4	56.1	108.6	4176.5	383.9
CV	21.16	0.46	1.78	4.71	2.78
<i>P Place</i>					
Seed-place	45.7a	56.2a	108.8a	4180.5a	382.6a
Side-band	42.5a	56.0a	108.7a	4173.5a	383.3a
<i>P Rate</i>					
0 kg/ha	47.6a	56.0a	107.5a	4170.9a	393.4a
20 kg/ha	45.3a	56.0a	108.9a	4046.6a	388.8a
40 kg/ha	42.9a	56.0a	108.9a	4134.3a	384.1a
60 kg/ha	42.9a	56.1a	110.0a	4147.7a	380.8a
80 kg/ha	46.8a	56.1a	107.8a	4320.0a	383.0a
100 kg/ha	42.7a	56.1a	108.1a	4236.5a	378.4a
<i>Rate * Place</i>					
Control	47.6a	56.0a	107.5a	4170.9a	393.4a
20 kg Side	45.9a	56.0a	108.8a	4091.1a	386.8a
40kg Side	39.0a	56.0a	107.8a	4119.1a	387.2a
60kg Side	43.9a	56.0a	111.8a	4167.0a	381.9a
80kg Side	40.6a	56.0a	107.8a	4263.0a	383.1a
100kg Side	43.1a	56.0a	107.3a	4227.5a	377.8a
20kg Seed	44.7a	56.0a	109.0a	4002.0a	390.8a
40kg Seed	46.8a	56.0a	110.0a	4149.4a	381.0a
60kg Seed	41.8a	56.3a	108.3a	4128.4a	379.6a
80kg Seed	52.9a	56.3a	107.8a	4377.0a	382.9a
100kg Seed	42.2a	56.3a	109.0a	4245.6a	379.0a

^zSignificance level of the p-value: *p<0.05, ** p<0.01, *** p<0.001

Table 7. Statistical analyses and treatment means for Faba bean yield and quality response to phosphorus (P) fertilization at Prince Albert, SK in 2022. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Prince Albert					
	Plant density ^z	Floweri ng ^z	Maturity ^z	Grain Yield ^z	TKW
	Plants/m ²	Days to	Days to	Kg/Ha	g/1000 seeds
P Rate (p-value)	0.5652	--	0.1374	0.0327	0.3061
P Placement (p-value)	0.0476	--	0.8499	0.6761	0.6682
Place * Rate (p-value)	0.5215	--	0.3358	0.1757	0.4494
Grand Mean	59.9	56.0	107.2	6683.0	477.0
CV	17.49	--	1.58	7.12	2.55
<u>P Place</u>					
Seed-place	56.9b	56.0	107.0b	6767.1a	475.7a
Side-band	63.3a	56.0	106.9b	6708.0a	477.4a
<u>P Rate</u>					
0 kg/ha	58.0a	56.0	109.3a	6138.1b	480.8a
20 kg/ha	64.0a	56.0	107.3a	6455.9ab	471.4a
40 kg/ha	55.3a	56.0	106.8a	6585.8ab	481.1a
60 kg/ha	61.3a	56.0	106.5a	6731.4ab	472.8a
80 kg/ha	62.5a	56.0	107.5a	6924.9ab	474.9a
100 kg/ha	57.5a	56.0	106.8a	6989.6a	482.9a
<u>Rate * Place</u>					
Control	58.0a	56.0	109.3a	6138.1a	480.8a
20 kg Side	65.0a	56.0	107.5a	6356.8a	474.0a
40kg Side	58.0a	56.0	107.0a	6498.6a	482.9a
60kg Side	63.0a	56.0	105.5a	6716.5a	472.5a
80kg Side	69.5a	56.0	107.5a	6791.8a	480.6a
100kg Side	61.0a	56.0	107.0a	7176.1a	477.2a
20kg Seed	63.0a	56.0	107.0a	6554.9a	468.8a
40kg Seed	52.5a	56.0	106.5a	6672.9a	479.2a
60kg Seed	59.5a	56.0	107.5a	6746.4a	473.0a
80kg Seed	55.5a	56.0	107.5a	7058.0a	469.1a
100kg Seed	54.0a	56.0	106.5a	6803.1a	488.6a

^zSignificance level of the p-value: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$