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Assessment of yield potential of different potato (*Solanum tuberosum* L.) varieties for seed production at high altitude Research Station Naltar Gilgit

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Introduction:

Potato (*Solanum tuberosum* L.) in Pakistan has gained an important place as being a very economical food crop for both producers and the consumers. It is ranked as fourth importantly cultivated crop by volume after the staple food crops (wheat, rice and maize) (Ahmad et al., 2021), so it plays a significant role to eradicate hunger in the world by feeding more peoples especially in the developing countries including Pakistan (Shiferaw et al., 2013). Being a member of Solanaceae family its species were originated from the tropical and southern areas of America (Peru as center of origin) as reported by Seifu and Betewulign, 2017. Potato having a high nutritive value and these contributes more protein and iron than other vegetables in the average diet and are also useful sources of thiamine, niacin and several other nutrients including fiber (Gupta & Gupta, 2019). Almost 86% of potato area and production of Pakistan is achieved from Punjab i.e. Okara, Sahiwal, Kasur, Sialkot, Sheikhupura, Jhang, Narowal, Pak Pattan, Gujranwala, Tobatech Singh, Khanewal and Lahore (Bakhsh & Ahmad, 2006). Remaining share is produced by KPK 9%, Baluchistan 4.5% and Sindh 0.5%. Pakistan is self-sufficient in potatoes for household consumption and relies for more than 99% on locally produced seed potatoes (Navarre et al., 2009). Presently, it is estimated that the total annual domestic production amounts to around 2.02 Million MT of which 280000 MT is used as seed and 1.7 Million MT is available for consumption after post-harvest losses with a population of roughly 150 Million, this accounts to 11 Kg per capita per annum (Caliskan et al., 2022).

According to Gilgit Baltistan Agriculture Statistics survey report 2014, potato is grown on an area of 9,116 hectares with a seed requirement of 16,868 tones and total production of 128,073 tons per annum. Out of the total produce, 19,853 tons is consumed locally, 108,220 ton is marketed in down country (Khan and Malik, 2023). The agro-ecological conditions of GB are highly suited for Seed Potato production for both spring and autumn crops of plains (Punjab and KPK Hussain et al.). In 2021-22 the total area under potato crop is 193.4 thousand hectares and total production is 4584.3 thousand tons, having a seed demand of 1,33,000 tons/annum (Agriculture Statistics of Pakistan 2021-2022). Currently Pakistan imports 9000-12000 tons seed potato annually investing huge foreign exchange, rest of the seed demand is met with poor quality seed resulting quite low yields. The potato sector also poses big opportunities for the GB potato grower to enter into the national market (Boubaker et al., 2023). Harvesting time of potato in GB starts from mid-July and continues up to end of September and during this season, there is stressing demand from corporate sector potato processor e.g. Lays chips of Pepsi-cola Pakistan and the small land holders can fetch ensured premium prices by producing potato (seed and table purpose) of varieties suited for table potato and value addition (chips) due to favorable environment, high isolated valleys and long sunny days, GB is just like a greenhouse for production of disease-

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free high quality seed potato, not only for local sowing but very important for autumn to autumn cycle in down country. The region of GB serves as a hub to secure national seed potato sector. This is the reason that the area wise share of GB potato in Pakistan is 6 % and production wise share is 10 % in respectively (Rehman et al., 2019).

Key words: Potato, *Solanum tuberosum*, exotic varieties, abiotic conditions, RCBD, analysis of variance, Naltar, Babusar, Gilgit-Baltistan.

Materials and Methods

A research trail was conducted by the scientists of this department at two different locations of GB. The tubers of potato varieties PRI Red and Rubby were provided by Potato Research Station, Sahiwal, Punjab while NARC-1, NARC-2 were provided by Horticulture Research Institute, NARC, Islamabad. The exotic varieties Kuroda, Barna and Melanto were obtained from National Indenters. The seed of these varieties were planted on 17th June at Babusar and 18th June 2021 at Naltar and the crop was harvested on 27th September 2021 in both locations. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In each replication 33 tubers of each variety were sown on ridges having plant to plant distance of 15 cm and row to row distance of 75 cm. Standard agronomic and plant protection measures were carried out during the whole cropping season. The DATA on various morphological parameters were recorded and analysis of variance was performed using software Statistics 8.1.

Results and Discussion

The analysis of variance using DATA for all the parameters depicted significant variations among all the tested varieties of potato. Comparison among mean values of the varieties was performed using LSD test. The results of the studied parameters are discussed as below.

Plant height

On the basis of field experiment at two different locations the variety NARC-2 depicted highest plant height (93.4 cm) at Babusar and 82.4 cm at Naltar followed by the newly introduced variety Rubby (87.6 cm) at Babusar and NARC-2 (78.2 cm). The variety Koruda showed least plant height (38.2 cm and 37. 7 cm) at Babusar and Naltar respectively (Table-1). The assessment report on comparison of potato varieties of (Zhao et al., 2023) strongly supports our results that the plant height is an inherited and complex trait as potato being an autohexatetraploid crop, therefore variation can be studied in this character. The finding of o(Raja et al., 2024) also reported significant differences in their research on the interaction of potato genotypes with environment and they envisaged that the variation in plants of potato is due to a combined effect of genetic makeup of potato variety and its interaction with the locality along with availability of nutrients and proper space etc.

Number of stems plant⁻¹

In the current study PRI Red showed maximum number of stems/ plant (5.2) followed by variety NARC-2 having 5.1 stems plant⁻¹ at Naltar followed by PRI Red (4.6) stems plant⁻¹ at Babusar. Minimum number of stems plant⁻¹ was observed in variety Koruda (2.3) at Naltar and 2.8 stems plant⁻¹ by the same variety at Babusar (Table-1). Khalid et, al. (2019) in his study also reported maximum number of stems (16.2) in potato variety Melanto. Likely Tufan & Öztürk, 2024, also concluded significant variation in potato varieties for this trait. Our research findings are similar to those reported by (Haque et al., 2025), they recorded 5.17 main stems in potato variety Diamant, whereas (Asnake et al., 2023) reported 5.2 main stems plant⁻¹ in potato variety Cardinal.

Number of tubers plant⁻¹

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The maximum number of tubers plant⁻¹ among the varieties was also envisaged that displayed highest number of tubers/plant for the variety PRI Red (18.1) followed by Rubby (13.7) at Babusar. Similarly, the variety PRI Red also exhibited maximum (7.8) tubers/plant followed by variety NARC-2. The analysis of variance depicted significant variation among the potato varieties under local climatic conditions of GB. The genetical attributes in correlation with the environmental factors as reported by Panday *et al.*; (2004); Panday *et al.*; (2008) are one of the main factors that effect tuberization in potato. Similar results were also reported by (Asnake *et al.*, 2023) who reported that bulky and larger size tubers with high production was due to better tuber germination along with vigorous plant growth and development in a suitable field using proper agronomic and plant protection and disease controlling measures.

Tuber weight plant⁻¹

For number of tubers plant⁻¹ five homogenous groups (a, ab, bc, abc, bc and c) among the means of nine varieties were found. The variety Melanto showed maximum weight of tubers plant⁻¹ 995.5 g followed by variety PRI Red (898.5 g), whereas minimum tuber weight per plant was observed in variety Kuroda (451g) as depicted in Table-1. The field investigation and the analysis of variance also revealed highly significant differences among the tested varieties of potato under the agro-ecological zones of GB. The studies of Tessema *et al.*, 2020 strongly agreed our conclusions that the attribute of tuber yield plant⁻¹ among the assessed potato varieties showed high degree of variation under in specific agro-ecological zone. The investigation of Das *et al.*, 2021; Tufan and Ozturk, 2024 reported that the higher tuber weight and tuber size in potato varieties are correlated with higher tuber germination accompanied with crop management practices, soil type and climatic factors of an area.

Yield hectare⁻¹

For comparison of yield, the analysis of variance provided three homogeneous groups (a, b and

c) For seven tested potato varieties in two different ecological areas of GB. The variety PRI Red

Emerged as best yielder with a production of 22.8 tons ha⁻¹ of seed potato followed by variety Melanto which yielded 16.9 tons ha⁻¹ of seed potato. The varieties Barna and Kuroda were observed as least yielders with a production of 11.9 and 13.2 tons ha⁻¹ at Naltar respectively. The findings of (Khalid *et al.*, 2023) also concluded that the yield potential of potato crop is dependent on variety, its genetic features and influence of various biotic and abiotic factors in an area. Many researchers investigated that the potato varieties had shown great variation in terms of yield and envisioned that tuber yield is a complex agronomic and genetical character that is highly influenced by a number of genes in a specified variety and it is correlated with better tuber germination, availability of water, farm yard manure, proper use of fertilizers and judicious use of chemicals (Tufan and Ozturk, 2024). The field study of Das *et al.*, 2021 also favor our results that the potato varieties showed significant variation for yield in a given locality. Similarly (Asnake *et al.*, 2023) studied various economically important potato varieties and

reported that variety Granola produced maximum yield 27.82 t ha⁻¹ followed by Asterix (26.83) and Provento (26.33) t ha⁻¹ and they reported high degree of variation amongst the test varieties of potato subject to the availability of all favorable climatic conditions accompanied with proper crop management practices that are considered as the key players to obtain higher yield from a given field under investigation.

Conclusions:

On the basis of field performance, the newly developed potato variety PRI Red by Potato Research Institute Sahiwal Punjab emerged as best yielding variety. Its production was recorded as 24.4 MT ha⁻¹ at Babusar, Diamer and 22.8 MT ha⁻¹ at Naltar Gilgit for seed potato production followed by variety Melanto (16.9 MT h⁻¹) at Naltar, Gilgit and with a production of 23.4 MT ha⁻¹

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1 at Babusar, Diamer. The two varieties / clones introduced by National Agriculture Research Centre Islamabad i.e. NARC-1 (13.5) and NARC-2 (12.9) MT ha⁻¹ performed satisfactorily at Naltar Gilgit; however there production was dropped at Babusar, Diamer due to changed abiotic conditions for acclimatization. The exotic varieties i.e. Kuroda and Barna produced least yield in the current study in both experimental areas facing strange environmental conditions in the new areas of production.

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Table 1: Comparison of different varieties of Potato for seed production at Potato and vegetable Research Station Naltar Gilgit

S. No.	Variety	Plant Height (cm)	No. of Stems Plant ⁻¹	No. of Tubers Plant ⁻¹	Tuber Weight Plant ⁻¹ (g)	Yield Plot ⁻¹ (kg)	Yield ha ⁻¹ (t)
1	PRI Red	72.5 c	5.2 a	7.8 a	898.5 b	16 a	22.8 a***
2	Rubby	68.5 d	4.5 ab	6.8 abc	496 e	11 bc	15.9 ab*
3	NARC-1	78.2 b	4.2 ab	6 cde	554 d	9.3 bc	13.5 b
4	NARC -2	82.4 a	5.1 a	7.2 ab	306.7 g	8.9 bc	12.9 b
5	Kuroda	37.7 e	2.3 c	5.2 de	451 f	8.5 bc	12.3 b
6	Barna	38.5 e	3.2 b	5.1 e	620.6 c	8.2 c	11.9 b
7	Melanto	68.1 d	4.6 ab	6.3 bcd	995.5 a	11.7 b	16.9 ab**

Table2: Comparison of different varieties of potato for seed production at Potato and Vegetable Research Station Babusar, Diamer

S. No.	Variety	Plant Height (cm)	No. of Stems Plant ⁻¹	No. of Tubers Plant ⁻¹	Tuber Weight Plant ⁻¹ (g)	Yield Plot ⁻¹ (kg)	Yield ha ⁻¹ (t)
1	PRI Red	72.6 c	4.6 b	18.1 a	1013 a	18.5 a	24.4 a*
2	Rubby	87.6 b	4.4 a	13.7 bc	1004 a	10.6 c	14 bc
3	NARC-1	88.7 b	3.3 bc	8.2 d	311 d	5.5 e	7.2 d
4	NARC-2	93.4 a	3.8 ab	9.6 cd	355 c	8 d	10.5 cd
5	Koruda	57.6 d	4.4 b	11.8 c	1012 a	14.6 b	19.3 b
6	Barna	38.2 e	2.8 c	15.2 b	670 b	7.6 d	10.1 cd

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7	Melanto	55.1 d	3.1 bc	8.4 cd	1011 a	17.7 a	23.4 a
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Table-03 Analysis of variance for plant height

Source	D.F	S.S	M.S	F	P
Rep	2	1.6	0.82	-	-
Area	1	353.0	353.05	-	-
Rep*Area	2	18.8	9.40	-	-
Variety	6	13936.4	2322.74	54.26	0.000
Error	30	1284.2	42.81	-	-
Total	41	15594.2	-	-	-

Grand Mean 66.515 CV 9.84

Table-04 Analysis of variance for number of stems plant⁻¹

Source	D.F	S.S	M.S	F	P
Rep	2	0.5490	0.27452	-	-
Area	1	2.8288	2.82881	-	-
Rep*Area	2	2.0433	1.02167	-	-
Variety	6	18.5529	3.09214	6.02	0.0003
Error	30	15.4071	0.51357	-	-
Total	41	39.3812	-	-	-

Grand Mean 4.0405 CV 17.74

Table 05: Analysis of variance for number of tubers plant⁻¹

Source	D.F	S.S	M.S	F	P
Rep	2	184	92	-	-
Area	1	340470	340470	-	-
Rep*Area	2	140	70	-	-
Variety	6	2139861	356644	18.02	0.0000
Error	30	593622	19787	-	-
Total	41	3074278	-	-	-

Table 06: Analysis of variance for total number of tubers plot⁻¹

Source	D.F	S.S	M.S	F	P
Rep	2	21.956	10.978	-	-
Area	1	321.487	321.487	-	-
Rep*Area	2	26.208	13.104	-	-
Variety	6	148.583	24.764	4.66	0.0019
Error	30	159.503	5.317	-	-
Total	41	677.736	-	-	-

Grand Mean 9.1095 CV 25.31

Table 07: Analysis of variance for yield plot⁻¹

Source	D.F	S.S	M.S	F	P
Rep	2	0.470	0.2352	-	-
Area	1	17.615 8	17.6152	-	-
Rep*Area	2	0.893	0.4467	-	-
Variety	6	458.166	76.3610	10.47	0.0000
Error	30	218.814	7.2938	-	-
Total	41	695.959	-	-	-

Grand Mean 11.138 CV 24.25

Table 08: Analysis of variance for yield ha⁻¹

Source	D.F	S.S	M.S	F	P
Rep	2	10.02	5.010	-	-
Area	1	8.75	8.750	-	-
Rep*Area	2	0.98	0.489	-	-
Variety	6	827.78	137.963	7.85	0.0000
Error	30	527.00	17.567	-	-
Total	41	1374.53	-	-	-

Grand Mean 15.186 CV 27.60

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