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## Response of Maize Hybrids/Cultivars to Various Levels of Potassium and Irrigation Frequencies

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**Abstract:** Field experiment was conducted during summer 2003 at Malakandher Research Farm, NWFP Agricultural University Peshawar, Pakistan to study the response of maize hybrids to various levels of potassium and irrigation frequencies. Statistical analysis of the data revealed that potassium @ 150 kg acre<sup>-1</sup> increased days to tasseling, grain weight cob<sup>-1</sup>, 1000 grain weight, grain yield and biological yield. Different hybrids respond significantly different for all the parameters. Maximum 52 days to tasseling, 152.9 g grain weight cob<sup>-1</sup>, 321.2 g thousand grain weight and 2790 kg acre<sup>-1</sup> grain yield was observed from plots irrigated weekly. However germination percentage and emergence m<sup>-2</sup> were not affected significantly by irrigation. Silking delayed by fortnightly irrigation. Monsanto 922 performed better than Pioneer 3025, Pioneer 3062 and Azam. Interaction between hybrid and potash showed that Monsanto 922 gave maximum grain yield 3676 kg acre<sup>-1</sup> when given 150 kg potash acre<sup>-1</sup>. Monsanto 922 also obtained maximum biological yield with 150 kg K acre<sup>-1</sup> and weekly irrigation.

**Key words:** Hybrids, cultivars, potassium, irrigation frequencies, maize

### INTRODUCTION

Among many other crops grown for grain and fodder purpose, maize is one of the most important cereal crops of Pakistan. In spite of its great yield potential the average maize yield in Pakistan is still low as compared to other maize growing countries of the world. Five major factors must be given prime attention to increase production of maize; soil, water, fertilizer, weed control and variety. The first four concerns with providing a suitable environment for crops growth and development, while the fifth crop variety relates to the inherent ability of the crop to provide within the existing environment. Maximum production of maize can be achieved by improving both the crop variety and growing it in a best environment. Though the evolution of disease resistant, fertilizer response, short saturated, high yielding varieties have revolutionized the maize production in Pakistan, yet the yield kg acre<sup>-1</sup> is much lower than its potential. This situation demand serious efforts on the part of researchers and planners to further boost up its production per acre yield. The present research project was initiated to study the response of different maize hybrids to potash levels and irrigation frequencies Saleem<sup>[1]</sup> and Shahzad<sup>[2]</sup> reported that grain yield of maize increased with increasing NPK rates. Six irrigations produced higher grain yield of 2415 kg ha<sup>-1</sup> as compared

to four irrigations. Cultivar Ishan response was more towards irrigation for plant height<sup>[3]</sup>. Maize was most responsive to applied K and P was not limiting. Sufficient P was applied to optimize and build soil test levels, but higher rates of K would be needed to increase soil K fertility. Leon<sup>[4]</sup> and Chaudhary<sup>[5]</sup>, stated that yield components like ear length, 1000-grain weight and number of grains ear<sup>-1</sup> remained unaffected like plant height, days taken to tasseling and silking remained unaffected, however, stalk yield and protein contents were significantly affected. Sadiq and Jan<sup>[6]</sup> reported that Potash applied at the rate of 180 kg ha<sup>-1</sup> had significantly delayed tasseling (50.33 days), silking (61.50 days). Significant positive linear relationship between different doses of with grain ear<sup>-1</sup>, 1000-grain yield was observed.

### MATERIALS AND METHODS

In order to study the response of four maize hybrids to different levels of potassium and irrigation frequencies in Peshawar valley an experiment was conducted at Malakandher research farm, NWFP Agricultural University Peshawar. The experiment was laid out in Randomized Complete Block Design with split plot arrangement with sub plot size of 3x4 m<sup>2</sup> which was composed of 6 rows 65 cm apart and were replicated four times. Four hybrids of maize (Pioneer 3062, Monsanto 922,

Pioneer 3025 and Azam) were sown with four levels of potassium (0, 50, 100, 150 kg acre<sup>-1</sup>). There were two irrigation frequencies (weekly, fortnightly). Irrigation and hybrids were allotted to main plots and potash levels to sub plots. Nitrogen 100 kg acre<sup>-1</sup>, phosphorous 50 kg acre<sup>-1</sup> and Zinc 5 kg acre<sup>-1</sup> was applied as recommended doses for hybrid maize. All standard agronomic practices were followed during the course of study.

Data regarding different parameters including emergence m<sup>-2</sup>, germination (%), days to 50% tasseling, days to 50% silking, grain weight cob<sup>-1</sup>, 1000 grain weight, grain yield (kg acre<sup>-1</sup>) and biological yield (kg acre<sup>-1</sup>) were recorded and analyzed statically.

**RESULTS AND DISCUSSION**

**Emergence m<sup>-2</sup>:** Data on emergence m<sup>-2</sup> presented (Table 1) revealed that emergence m<sup>-2</sup> was not affected by potash, irrigation and their interaction. This non-significant effect may be due to no role of potash and irrigation during germination at same moisture level. However different hybrids significantly affected emergence m<sup>-2</sup>, as maximum 7.2 plants m<sup>-2</sup> were emerged from plots of Monsanto 922 followed by 7.1 plants m<sup>-2</sup> emerged by Azam while minimum 7 plants m<sup>-2</sup> were emerged from plots of Pioneer 3062. This might be due to difference in genetic potential of different hybrids<sup>[7]</sup>.

**Germination percentage:** Statistical analysis of the data revealed that germination percentage was significantly affected by different hybrids (Table 2). As maximum germination percentage 98.46% was recorded from plots of Monsanto 922 while Pioneer 3025 produced minimum 95.96%. This is might be due to seed viability of different hybrids because germination is mainly dependent on the seed reserves. Mean values of the data showed that different potash levels and irrigation had no influence on germination percentage. The possible reason for this nonsignificant effect is that it was too early to effect of potash doses and irrigation on germination percentage.

**Days to 50% tasseling:** It is clear from the data regarding days to 50% tasseling presented (Table 3) that main effect of all the three factors were significant. Maximum 52 days to 50% tasseling was noted when weekly irrigated while fortnightly irrigation gave minimum 49 days to 50% tasseling. It is supported by Kashmir and Taj<sup>[3]</sup> who reported that more irrigation delays the tasseling. Similarly mean value of the data also revealed that hybrid and potash affected significantly days to 50% tasseling. Maximum 53 days to 50% tasseling was noted for hybrid Pioneer 3062 while Azam took minimum 46 days to tasseling. It may be due to genetic character of maize hybrids. In case of potash plots of 150 kg K acre<sup>-1</sup> recorded maximum 52 day to 50% tasseling and it was statistically significant from the rest of K doses.

Table 1: Emergence m<sup>-2</sup> of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	7.05	7.13	7.05	7.05	7.07
	Monsanto 992	7.25	7.07	7.22	7.25	7.20
	Pioneer 3025	7.05	7.18	7.25	7.10	7.15
	Azam (Cv.)	7.22	7.07	7.22	7.22	7.18
Fortnightly	Pioneer 3062	7.03	7.00	7.07	7.03	7.03
	Monsanto 992	7.22	7.22	7.20	7.25	7.22
	Pioneer 3025	7.13	7.15	7.05	7.22	7.14
	Azam (Cv.)	7.18	7.18	7.18	7.15	7.17
		HxK				H
		IxK				I
		IxH				IxH
		IxK				I
Weekly		7.14	7.11	7.19	7.16	7.15
Fortnightly		7.14	7.14	7.13	7.16	7.14
	Mean (Potash)	7.14	7.13	7.16	7.16	

LSD value (0.05) for hybrids = 0.0822, Mean values of the same category followed by different letter are significant at p≤0.05 level

**Table 2: Germination percentage of maize hybrids/cultivar as affected by irrigation and potash levels**

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	96.65	96.88	96.78	96.63	96.74
	Monsanto 992	98.50	98.45	98.38	98.43	98.44
	Pioneer 3025	96.20	95.55	96.00	95.85	95.90
	Azam (Cv.)	96.65	96.82	96.93	96.75	96.79
Fortnightly	Pioneer 3062	96.77	96.15	96.45	96.30	96.42
	Monsanto 992	98.43	98.60	98.38	98.55	98.49
	Pioneer 3025	96.18	96.13	95.95	95.85	96.03
	Azam (Cv.)	96.35	96.50	96.80	96.53	96.55
		HxK				H
	Pioneer 3062	96.71	96.52	96.62	96.47	96.58b
	Monsanto 992	98.47	98.53	98.38	98.49	98.47a
	Pioneer 3025	96.19	95.84	95.98	95.85	95.96c
	Azam (Cv.)	96.50	96.66	96.87	96.64	96.67b
		IxK				I
Weekly		97.00	96.93	97.02	96.92	96.97
Fortnightly		96.93	96.85	96.90	96.81	96.87
	Mean (Potash)	96.97	96.89	96.96	96.86	

LSD value (0.05) for hybrids = 0.3218, Mean values of the same category followed by different letter are significant at  $p \leq 0.05$  level

**Table 3: Days to tasseling of maize hybrids/cultivar as affected by irrigation and potash levels**

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	53.00	53.25	55.00	56.25	54.38a
	Monsanto 992	51.00	52.75	55.00	56.25	53.75ab
	Pioneer 3025	50.75	52.25	53.25	54.50	52.69bc
	Azam (Cv.)	45.75	46.50	47.50	49.75	47.38e
Fortnightly	Pioneer 3062	50.75	51.50	52.50	54.50	52.31c
	Monsanto 992	51.00	52.50	53.25	54.00	52.69bc
	Pioneer 3025	47.25	49.00	49.50	51.25	49.25d
	Azam (Cv.)	42.25	46.00	45.00	46.25	44.88f
		HxK				H
	Pioneer 3062	51.88	52.38	53.75	55.38	53.34a
	Monsanto 992	51.00	52.63	54.13	55.13	53.22a
	Pioneer 3025	49.00	50.63	51.38	52.88	50.97b
	Azam (Cv.)	44.00	46.25	46.25	48.00	46.13c
		IxK				I
Weekly		50.13	51.19	52.69	54.19	52.05a
Fortnightly		47.81	49.75	50.06	51.50	49.78b
	Mean (Potash)	48.97d	50.47c	51.38b	52.84a	

LSD value (0.05) for irrigation = 0.5339, LSD value (0.05) for hybrids = 0.755, LSD value (0.05) for IxH = 1.068, LSD value (0.05) for potash = 0.6734  
 Mean values of the same category followed by different letter are significant at  $p \leq 0.05$  level

**Days to 50% silking:** It can be inferred from the mean value of the data that all the three factors (hybrids, potash and irrigation) were significantly affected days to 50% silking (Table 4). However interaction effect was not significant. Monsanto 922 took maximum 63 days to 50% silking while minimum 54 days to 50% silking was recorded from plots of Azam. This variation may be due to different genetic ability of hybrids. This is supported by Zulfiqar and Amir<sup>[8]</sup> who concluded that different hybrids/cultivar shows different days to silking. Similarly fortnightly irrigation took maximum 60 days to 50% silking as compared to weekly irrigation that took minimum

57 days to 50% silking. It is clear from the results that less irrigation cause delay in silking and silking does not correspond to tasseling. In case of potash levels control plots took maximum 61 days to 50% silking while plots given 150 kg acre<sup>-1</sup> potash took minimum 57 days to 50% silking.

**Grain weight cob<sup>-1</sup>:** It can be inferred from the data concerning grain weight cob<sup>-1</sup> that main effect of all the three factors and a first order interaction effect were significant on grain weight cob<sup>-1</sup>. Table 5 indicated that maximum grain weight cob<sup>-1</sup> 160 g was produced by

Table 4: Days to silking of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	60.75	58.00	57.25	56.25	58.06
	Monsanto 992	63.75	64.00	62.00	61.50	62.81
	Pioneer 3025	58.50	57.75	57.50	56.00	57.44
	Azam (Cv.)	55.50	53.75	53.00	52.25	53.63
Fortnightly	Pioneer 3062	64.00	61.75	58.75	57.75	60.56
	Monsanto 992	66.50	66.75	63.75	62.75	64.94
	Pioneer 3025	63.00	60.75	59.00	58.25	60.25
	Azam (Cv.)	56.75	55.50	57.00	53.75	55.75
		HxK				H
	Pioneer 3062	62.38	59.88	58.00	57.00	59.31b
	Monsanto 992	65.13	65.38	62.88	62.13	63.88a
	Pioneer 3025	60.75	59.25	58.25	57.13	58.84b
	Azam (Cv.)	56.13	54.63	55.00	53.00	54.69c
		IxK				I
Weekly		59.63	58.38	57.44	56.50	57.98b
Fortnightly		62.56	61.19	59.63	58.13	60.38a
	Mean (Potash)	61.09a	59.78b	58.53c	57.31d	

LSD value (0.05) for irrigation = 0.4532, LSD value (0.05) for hybrids = 0.641, LSD value (0.05) for potash = 0.7512, Mean values of the same category followed by different letter are significant at  $p \leq 0.05$  level

Table 5: Grain weight cob<sup>-1</sup> (g) of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	131.8	136.6	159.8	172.0	150.0
	Monsanto 992	133.8	157.1	182.5	184.8	164.6
	Pioneer 3025	144.5	153.5	167.2	171.5	159.2
	Azam (Cv.)	128.1	137.3	146.4	139.9	137.9
Fortnightly	Pioneer 3062	125.1	134.7	152.8	151.2	141.0
	Monsanto 992	130.4	151.1	171.2	170.3	155.7
	Pioneer 3025	139.5	146.6	165.9	166.4	154.6
	Azam (Cv.)	119.8	130.5	141.2	136.1	131.9
		HxK				H
	Pioneer 3062	128.5 jk	135.6h-j	156.3c-e	161.6b-d	145.5b
	Monsanto 992	132.1ijk	154.1d-f	176.9 a	177.5a	160.1a
	Pioneer 3025	142.0g-l	150.0e-g	166.5a-c	169.0ab	156.9a
	Azam (Cv.)	123.9k	133.9h-k	143.8f-h	138.0h-j	134.9c
		IxK				I
Weekly		134.5	146.1	164.0	167.1	152.9a
Fortnightly		128.7	140.7	157.8	156.0	145.8b
	Mean (Potash)	131.6c	143.4b	160.9a	161.5a	

LSD value (0.05) for irrigation 4.102, LSD value (0.05) for hybrids = 5.801, LSD value (0.05) for potash = 5.803, LSD value (0.05) for IxH = 11.61 Mean values of the same category followed by different letter are significant at  $p \leq 0.05$  level

hybrid Monsanto 922 and minimum grain weight 134 g was noted by Azam. It might be due to genetic ability of hybrid to produce heavier grain weight cob<sup>-1</sup> than synthetic variety. Among potash levels maximum 161.9 g grain weight cob<sup>-1</sup> was obtained from the plots fertilized with 150 kg acre<sup>-1</sup> of potash while control plots produced minimum grain weight cob<sup>-1</sup>. The interaction (HxK) effect shows that maximum 177 g grain weight cob<sup>-1</sup> was produced from plots of Monsanto 922 when given potash @ 150 kg acre<sup>-1</sup>, while minimum 123 g grain weight was produced by Azam in control plots. This might be due

to the reason that hybrid response to potassium was more as compared to Azam.

**1000-grain weight:** Statistical analysis of the data revealed that hybrids shows significant different 1000-grain weight. It is clear from the data that heavier grains (359 g) were recorded from Monsanto 922 while Azam gave lighter grains. This difference may be due to the different grain size of different hybrids produce heavier grains than synthetic variety. In case of irrigation and potash levels, weekly irrigation and 150 kg acre<sup>-1</sup>

Table 6: One thousand grain weight (g) of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		-----				
		I x H x K				I x H
		-----				
Weekly	Pioneer 3062	262.9	289.8	360.1	366.3	319.7c
	Monsanto 992	322.3	338.3	391.5	415.5	366.9a
	Pioneer 3025	255.3	297.8	334.0	363.3	312.6c
	Azam (Cv.)	214.5	282.8	323.0	321.5	285.4d
Fortnightly	Pioneer 3062	223.8	234.8	302.8	306.0	266.8e
	Monsanto 992	296.3	329.3	379.5	401.5	351.6b
	Pioneer 3025	222.0	277.0	322.5	323.8	286.3d
	Azam (Cv.)	198.5	239.3	316.3	324.3	269.6e
		-----				
		H x K				H
		-----				
	Pioneer 3062	243.3	262.3	331.4	336.1	293.3b
	Monsanto 992	309.3	333.8	385.5	408.5	359.3a
	Pioneer 3025	238.6	287.4	328.3	343.5	299.4b
	Azam (Cv.)	206.5	261.0	319.6	322.9	277.5c
		-----				
		I x K				I
		-----				
Weekly		263.7	302.1	352.1	366.6	321.2a
Fortnightly		235.1	270.1	330.3	338.9	293.6b
	Mean (Potash)	249.4c	286.1b	341.2a	352.8a	

LSD value (0.05) for irrigation = 6.296, LSD value (0.05) for hybrids = 8.904, LSD value (0.05) for I x H = 12.59, LSD value (0.05) for potash = 11.98  
 Mean values of the same category followed by different letter are significant at p ≤ 0.05 level

Table 7: Grain yield (kg acre<sup>-1</sup>) of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		-----				
		I x H x K				I x H
		-----				
Weekly	Pioneer 3062	2164	2666	3581	3681	3023
	Monsanto 992	2036	3071	3552	3881	3135
	Pioneer 3025	2392	2782	3475	3828	3119
	Azam (Cv.)	1066	1612	2291	2568	1884
Fortnightly	Pioneer 3062	1883	2229	3223	3305	2660
	Monsanto 992	1618	2527	3264	3470	2720
	Pioneer 3025	2139	2294	2906	3110	2612
	Azam (Cv.)	900	1235	2098	2137	1592
		-----				
		H x K				H
		-----				
	Pioneer 3062	2024hi	2447ef	3402b	3493ab	2841a
	Monsanto 992	1827i	2799d	3408b	3676a	2927a
	Pioneer 3025	2265fg	2538e	3190c	3469b	2866a
	Azam (Cv.)	983k	1423j	2194gh	2353efg	1738b
		-----				
		I x K				I
		-----				
Weekly		1914	2533	3224	3489	2790a
Fortnightly		1635	2071	2872	3006	2396b
	Mean (Potash)	1775d	2302c	3048b	3248a	

LSD value (0.05) for irrigation = 100.7, LSD value (0.05) for hybrids = 142.4, LSD value (0.05) for potash = 98.66, LSD value (0.05) for H x K = 197.3  
 Mean values of the same category followed by different letter are significant at p ≤ 0.05 level

potash produce heavier 1000 grains 321 and 352 g, respectively while lighter 1000-grain fortnightly irrigation and control plots produced weight. Interaction (I x H) effect shows that Monsanto 922 gave maximum 1000-grain weight 366 g when weekly irrigated while minimum 1000-grain weight 266 g was recorded from the plots of Pioneer 3025 when fortnightly irrigated Kashmir and Taj<sup>[3]</sup> also reported that different hybrids response to irrigation is significantly different.

**Grain yield:** Data presented in Table 7 revealed that main effect of all the three factors and interaction (H x K) effect was significant for grain yield kg acre<sup>-1</sup>. As maximum grain yield 2927 kg acre<sup>-1</sup> was recorded from plots of Monsanto 922 while Azam gave minimum 1738 kg acre<sup>-1</sup> grain yield. In case of potash and irrigation levels influence on grain yield maximum 3248 and 2790 kg acre<sup>-1</sup> grain yield was recorded by plots given 150 kg acre<sup>-1</sup> potash and weekly irrigation, respectively, while minimum

Table 8: Biological yield (kg acre<sup>-1</sup>) of maize hybrids/cultivar as affected by irrigation and potash levels

Irrigation	Hybrids	Potash levels (kg acre <sup>-1</sup> )				Mean
		Control	50	100	150	
		IxHxK				IxH
Weekly	Pioneer 3062	9286h-m	9875d-I	11461abc	12104ab	10681
	Monsanto 992	9600f-k	10131d-h	10651c-f	11386a-c	10442
	Pioneer 3025	9320h-m	10075d-h	11239bc	12348a	10745
	Azam (Cv.)	8118no	8606k-o	10682c-e	11436a-c	9710
Fortnightly	Pioneer 3062	8880i-n	8903i-n	9799e-j	10704cde	9572
	Monsanto 992	8407m-o	6714p	9690e-j	10465c-g	8819
	Pioneer 3025	8792j-n	9492g-l	9865d-I	10888cd	9759
	Azam (Cv.)	7697op	8477l-o	9013i-n	8986i-n	8543
		HxK				H
	Pioneer 3062	9083	9389	10630	11404	10127a
	Monsanto 992	9003	8423	10170	10926	9631b
	Pioneer 3025	9056	9783	10552	11618	10252a
	Azam (Cv.)	7908	8542	9848	10211	9127c
		IxK				I
Weekly		9081	9672	11008	11819	10395a
Fortnightly		8444	8396	9592	10261	9173b
	Mean (Potash)	8762c	9034c	10300b	11040a	

LSD value (0.05) for irrigation = 345.7, LSD value (0.05) for hybrids = 488.9, LSD value (0.05) for potash = 374.4, LSD value (0.05) for IxH x K = 1059  
 Mean values of the same category followed by different letter are significant at p ≤ 0.05 level

grain yield 1775 and 2396 kg acre<sup>-1</sup> were recorded in control plot and fortnightly irrigation, respectively. These results are in line with those reported by other researchers<sup>[2,9-11]</sup>, who reported that grain yield was increased with the increasing K doses. All hybrids produced higher grain yield than synthetic variety. It might be due to decrease in ear size of synthetic variety as compared to hybrids. Grain yield increased with increase in fertilizer and irrigation levels<sup>[3,5]</sup>. Interaction (HxK) effect shows that Monsanto 922 gave maximum 3676 kg acre<sup>-1</sup> grain yield when given potash @ 150 kg acre<sup>-1</sup>. While minimum 982 kg acre<sup>-1</sup> Azam when irrigated fortnightly-recorded grain yield. It might be due to different response of different hybrids to different potash levels.

**Biological yield:** Data pertaining biological yield Table 8 shows that all the factors had significant influence on biological yield. Hybrid Pioneer 3025 produced maximum 10250 kg acre<sup>-1</sup> biological yield as compared to Azam, which produced minimum 9127 kg acre<sup>-1</sup> biological yield. Influence of potash and irrigation showed from mean values of the data that 150 kg K acre<sup>-1</sup> and weekly irrigation produced maximum 11040 kg acre<sup>-1</sup> and 10390 kg acre<sup>-1</sup>, respectively as compared to minimum 8762 and 9173 kg acre<sup>-1</sup> biological yield from control plots and fortnightly irrigation. The findings of A. Sadiq and Amanullah<sup>[12]</sup> are also same. The mean values of the data also indicated that a second order interaction (IxHxK) was highly significant. Pioneer 3025 gave maximum 12350 kg acre<sup>-1</sup> biological yield when weekly irrigated and

given 150 kg acre<sup>-1</sup> potash while minimum 6714 kg acre<sup>-1</sup> biological yield was produced by Monsanto 922 irrigated fortnightly and given potash 50 kg acre<sup>-1</sup>. These results are in line with those of Stauffer *et al.*<sup>[13]</sup> who reported that hybrid produce more biological yield than synthetic variety.

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