Variation in agronomic performance and grain quality of Indian maize landraces of high altitude region of Jammu Kashmir and Himachal Pradesh

Ashok Kumar, Jyoti Kumari*, J C Rana, Dharam Paul[1], Ram Kumar, Harendra Singh and T P Singh

National Bureau of Plant Genetic Resources, New Delhi-110 012; [1]Directorate of Maize Research, New Delhi

*Communicating email id: jj.gene@gmail.com

Abstract

India has a vast diversity in maize landraces characteristics grown under different agro ecologies. In this study, the landraces of Norh-western Himalayan region were studied for their variability for agronomic and biochemical traits. The landraces were evaluated in Delhi during rainy seasons of 2008 and 2009. There were significant difference between landraces of Jammu Kashmir and Himachal Pradesh for protein content, tryptophan content, test weight, days to tassel, days to silk, plant height, ear height and number of kernel rows. Based on coeeficient of variance, landarces of Himachal Pradesh were more variable in comparison to Jammu Kashmir. Altogether landraces of both the places were variable for yield per plant, test weight, ear height and tryptophan content. The boxplot depicted that landraces of Jammu Kashmir has more average value of protein, oil, sugar and starch content whereas landraces of Himachal Pradesh has more content of tryptophan and specific gravity.

Keywords: maize landraces, grain yield, grain number, protein, sugar, genetic resources

Introduction

Maize (*Zea mays* L.) is grown in different environmental regimes both in the tropical and temperate regions. Due to its pollination mechanism, landraces in maize are genetically heterogeneous populations that are typically selected by farmers for their adaptation to specific

local environments and are understood to differ in agronomic and nutritional characteristics, including biotic and abiotic stress resistance etc. Diverse arrays of maize landraces are found globally due to natural and artificial selections. They have evolved under subsistence agriculture and are still cultivated by farmers in different regions worldwide, including India. A maize landrace is mostly defined by the farmer in terms of ear characteristics; ear type is usually maintained by the farmers through conservative selection in spite of considerable gene flow (Louette and Smale 2000). Yet, it is relevant to note that only a tiny fraction of this valuable diversity is used in maize breeding programmes around the world (Dowswell *et al*. 1996), indicating that much of this diversity remains to be characterized, evaluated and utilized. For better conservation and utilization of such germplasm, it is important to generate proper agronomic and genetic knowledge (Nass *et al*. 1993).

India has a wide diversity of maize landraces in all maize growing areas from low to high altitude. These are prevalent in diverse agroecologies, extending from the extreme semi-arid to subhumid and humid regions (Singh 1977, Prasanna and Sharma 2005, Prasanna 2010). These genetic resources find significant area in Madhya Pradesh (82%), Uttar Pradesh (42%), and Bihar (45%) during the rainy (*kharif*) season (Joshi *et al*. 2005). Extensive variability in plant type, phenological characters, tassel and ear characteristics of local varieties grown by the farmers in the North Eastern Himalayan (NEH) and Northwestern highlands in India was reported (Singh 1977). National Bureau of Plant Genetic Resources (NBPGR) genebank conserves around 9000 accessions of maize landraces including indigenous collection, exotic material, genetic stocks, inbred lines etc. in the long term storage. Many of these landrace accessions have specific characteristic features, but only a few of them have been utilized in maize improvement programmes (Prasanna and Sharma 2005). The reason being that only few

systematic studies have been conducted to characterize and evaluate these landraces to know its best potential (Chandel and Bhat, 1989, Prasanna and Sharma 2005, Vasala, 2013). However the landraces of North western Himalayan landraces are not well studied. The present study was, therefore, undertaken to evaluate the grain quality and agronomic performances of selected landrace accessions of North Western India with specific focus on Himachal Pradesh and Jammu Kashmir.

Material and methods

Experiment I

The landraces were collected from Jammu Kashmir (30) and Himachal Pradesh (45) during year 2007 and 2008 respectively. These were grown at the NBPGR farm, New Delhi during year 2009 for preliminary characterization and seed increase in Augmented Block Design with three checks Madhuri, Navjot and Jawahar Pop Corn. The second year evaluation was repeated for the same number of treatments and controls during year 2009. The data were recorded for 6 qualitative traits and 15 quantitative characteristics according to the minimal descriptors developed by the NBPGR. The mean data of quantitative traits for each treatment were adjusted using augmented block design analysis using SAS Macro. The adjusted mean data were used for comparison between groups, descriptive statistics and box plot using IBM SPSS Statistics 20 software.

Experiment II

The experimental material for the biochemical analysis included representative samples of maize landraces from the first experiment which included 51 landraces (Table 1), 11 belonged to Doda, Kishtawar and Ramban districts of Jammu-Kashmir and 41 were from Chamba, Kangra, Kullu,

Mandi and Hamirpur districts of the Himachal Pradesh. The selected maize landraces were evaluated for 6 biochemical parameters including protein content, oil content, sugar content, starch content (Kumari *et al*., 2007), specific gravity and tryptophan content in protein on the dry weight basis using triplicate samples from each treatment.

Result and discussion

Understanding the extent and patterns of genetic diversity within germplasm accessions, particularly landraces of particular region, is important for effective future collection, development of conservation strategies and efficient use of these genetic resources (Frankel *et al*. 1995). Harlan *et al*. (1973) suggested that agronomic and ecological characteristics could influence the genotypic constitution of landraces during domestication, and hence a relation exists between the agro-ecology of the collection region and the morpho-physiological make-up of the landraces. The significance of phenotypic evaluation of maize landraces was highlighted by studies undertaken in various countries, including Canada (Azar *et al*. 1997), Turkey (Ilarslan *et al*. 2002), Mexico (Pressoir and Berthaud 2004), India (Prasanna and Lata, 2005).

There were significant difference between landraces of Jammu Kashmir and Himachal Pradesh for protein content, tryptophan content, test weight, days to tassel, days to silk, plant height, ear height and number of kernel rows (Table 2). Landraces of Jammu-Kashmir has early maturity as indicated by mean value of 90 days in comparison to mean value 96 days in case of landraces of Himachal Pradesh. The anthesis silking interval of landraces of Jammu Kashmir was also lower than Himachal Pradesh, this may be indicative of source of drought tolerance genes, as this trait is negatively associated with high drought tolerance (Ngugi *et al.,* 2013). Based on coefficient of variance, landraces of Himachal Pradesh has more variability in comparison to Jammu Kashmir. The study by Chandel and Bhat, 1989 had reported existence of

high genetic variability for most of the cobs and seed characters, plant height, cob size, shape, number of grain rows/cob and colours. The maize landraces also showed considerable range for crude protein content, total grain yield, lodging etc. Their study showed that the North Western Himalayas is potential centre of landrace diversity in maize.

However, landraces of both the places were more variable for yield per plant, test weight, ear height and tryptophan content (Table 3). The boxplot analysis clearly depicted that landraces of Jammu Kashmir has more average value of protein, oil, sugar and starch content whereas landraces of Himachal Pradesh has more content of tryptophan and specific gravity (fig 1). Similarly for agronomic traits, landraces of Jammu Kashmir was taller with high ear placement and had early maturity (fig 2). In Jammu and Kashmir, maize is second most important crop after rice and is a staple food of tribal areas such as Gujar and Bakarwall (nomadic race). In Kashmir Valley maize is grown as a sole crop at an altitude range of 1850-2300 m above mean sea level. However it also occupies plain belts of the valley in few pockets with scanty moisture. The descriptions of landraces grown in the Kashmir valley are mentioned by Najeeb *et al.,* 2012. The landrace IC556421 collected from Ramban area had highest protein (13.27 %) and sugar content (4.53%) and moderate amount of oil content (4.06%). As far as oil content is concerned, IC568267 of Himachal region had highest oil content and IC5468265 had the largest seed weight (36.59), hence may be used for base population or inbred development. To conclude with landraces of North Western Himalayan region has large variability for the grain quality traits and agronomic traits, which can be exploited for genetic improvement. Further study in this direction is warranted to study in more detail about the specific characteristics such as biotic and abiotic stress and nutritional aspects.

References

Azar C, Mather D E and Hamilton R I. 1997. Maize landraces of the St. Lawrence–Great Lakes region of North America. *Euphytica* **98**: 141–8.

Chandel, K P S and Bhat, K V. 1989. North Western Himalaya- A centre of maize diversity. *Indian J Plant Genet Resour*. **2**(1):12-17.

Dowswell C R, Paliwal R L and Cantrell R L. 1996. *Maize in the Third World.* Westview Press, USA.

Frankel O H, Brown A D H and Burdon J J. 1995. Conservation of Plant Biodiversity. Cambridge University Press, Cambridge, England.

Harlan J R, de Wet J M J and Price E G. 1973. Comparative evolution of cereals. *Evolution* **27**: 311–25.

Ilarslan R, Kaya Z, Kandemir I and Bretting P K. 2002. Genetic variability among Turkish pop, flint and dent corn (*Zea mays* L.) races: morphological and agronomic traits. *Euphytica* **128**: 173–82.

Joshi P K, Singh N P, Singh N N, Gerpacio R V and Pingali P L. 2005. *Maize in India: Production System, Constraints and Research Priorities.* CIMMYT, Mexico.

Ngugi Kahiu, Jerono Cheserek, Cecilia Muchira and George Chemining. 2013. Anthesis to Silking Interval Usefulness in Developing Drought Tolerant Maize. *J Renewable Agric* 2013, **1**(5): 84-90

Kumari Jyoti, Gadag R N, and Jha G K. 2007. Genetic analysis and correlation in sweet corn (*Zea mays*) for quality traits, field emergence and grain yield. *Indian J Agric Sci* **77**(9):613-615.

Louette D, Charrier A and Berthaud J. 1997. In situ conservation of maize in Mexico: genetic diversity and maize seed management in a traditional community. *Econ Bot* **51**: 20–38.

Nass L L, Pellicano I T and Valois A C C. 1993. Utilization of genetic resources for maize and soybean breeding in Brazil. *Brazilian J Genet* **16**: 983–8.

Prasanna B M and Sharma L. 2005. The landraces of maize (*Zea mays* L.) diversity and utility. *Indian J Pl Genet Resour* **18**: 155–68.

Prassana B M. 2010. Phenotypic and molecular diversity of maize landraces: Charactgerization and utilization. *Indian J Genet* **70**: 315–27.

Pressoir G and Berthaud J. 2004. Patterns of population structure in maize landraces from the Central Valleys of Oaxaca in Mexico. *Heredity* **92**: 88–94.

Najeeb S, Rather AG, Zarger MA, Ahangar FA, Sheikh GA, Parray ZA, Bhat, PA Sofi, Subash C Kashap, Ishfaq A, Dar ZA, Mehfoza H and Bardi ZA. 2012. Maize landraces of kashmir: present status and future prospects. *Maize Genet Coop Newslett* . **86**

Singh B. 1977. Races of Maize in India. Indian Council of Agricultural Research (ICAR), New Delhi.

Wasala S K, Guleria S K, Sekhar J C, Mahajan V, Srinivasan K, Parsad R and Prasanna B M. 2013. Analysis of yield performance and genotype × environment effects on selected maize (*Zea mays*) landrace accessions of India. *Indian J Agric Sci* **83** (3): 287–93.

Table 1. List of selected maize landraces used for detailed study

Accession	Dist	State	Latitude, longitude	Altitude(m)
IC556400	Doda	JK	33.14, 75.54	1107
IC556401	Doda	JK	33.14, 75.54	1107
IC556409	Doda	JK	33.14, 75.54	1107
IC556410	Doda	JK	33.14, 75.54	1107
IC556411	Kishtwar	JK	33.31, 75.76	1685
IC556413	Kishtwar	JK	33.31, 75.76	1685
IC556414	Ramban	JK	33.24, 75.23	1156
IC556415	Ramban	JK	33.24, 75.23	1156
IC556416	Ramban	JK	33.24, 75.23	1156
IC556419	Ramban	JK	33.24, 75.23	1156
IC556421	Ramban	JK	33.24, 75.23	1156
IC556424	Chamba	HP	32.55, 76.12	996
IC556425	Chamba	HP	32.55, 76.12	996
IC556429	Chamba	HP	32.55, 76.12	996
IC556430	Kangra	HP	32.10, 76.27	733
IC556431	Kangra	HP	32.10, 76.27	733
IC556432	Kangra	HP	32.10, 76.27	733
IC556433	Kangra	HP	32.10, 76.27	733
IC556435	Hamipur	HP	31.68, 76.52	785
IC556436	Hamipur	HP	31.68, 76.52	785
IC568235	Mandi	HP	31.70, 76.93	1524
IC568238	Mandi	HP	31.70, 76.93	1524
IC568243	Hamipur	HP	31.68, 76.52	785
IC568244	Hamipur	HP	31.68, 76.52	785
IC568245	Hamipur	HP	31.68, 76.52	785
IC568247	Hamipur	HP	31.68, 76.52	785
IC568248	Kullu	HP	31.95, 77.10	120
IC568251	Kullu	HP	31.95, 77.10	120
IC568254	Kullu	HP	31.95, 77.10	120
IC568256	Kullu	HP	31.95, 77.10	120
IC568265	Chamba	HP	32.55, 76.12	996
IC568267	Chamba	HP	32.55, 76.12	996
IC568269	Chamba	HP	32.55, 76.12	996
IC568272	Kangra	HP	32.10, 76.27	733
IC568274	Kangra	HP	32.10, 76.27	733
IC568279	Kangra	HP	32.10, 76.27	733
IC568282	Kangra	HP	32.10, 76.27	733
IC568283	Kangra	HP	32.10, 76.27	733

IC568286	Kangra	HP	32.10, 76.27	733
IC568290	Kangra	HP	32.10, 76.27	733
IC568292	Kangra	HP	32.10, 76.27	733
IC568293	Kangra	HP	32.10, 76.27	733
IC568295	Kangra	HP	32.10, 76.27	733
IC568296	Kangra	HP	32.10, 76.27	733
IC568298	Kangra	HP	32.10, 76.27	733
IC568299	Kangra	HP	32.10, 76.27	733
IC568304	Chamba	HP	32.55, 76.12	996
IC568306	Chamba	HP	32.55, 76.12	996
IC568307	Chamba	HP	32.55, 76.12	996
IC568310	Chamba	HP	32.55, 76.12	996
IC568312	Chamba	HP	32.55, 76.12	996

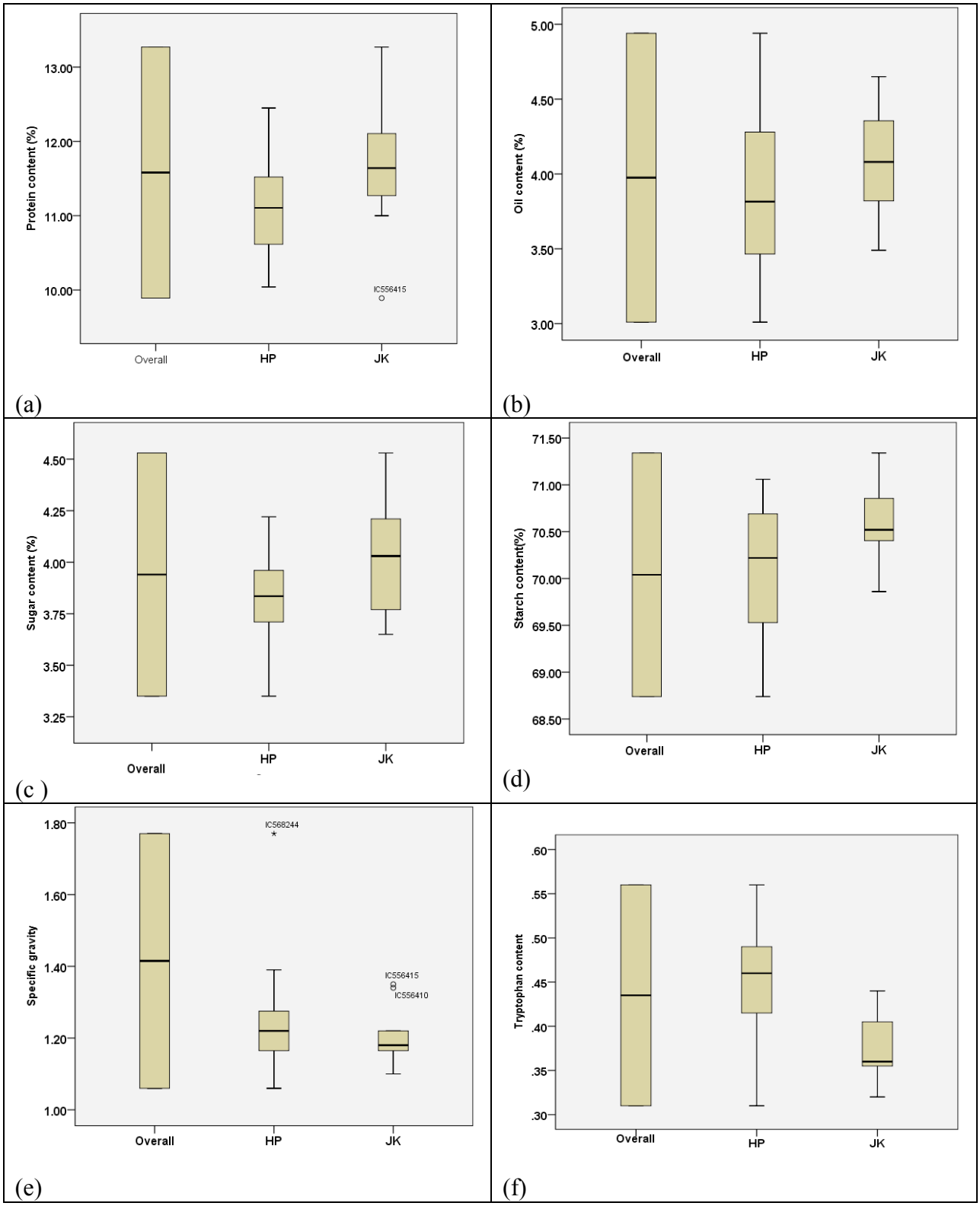

Fig 1 (a-f). Box plot showing variation in grain quality parameters

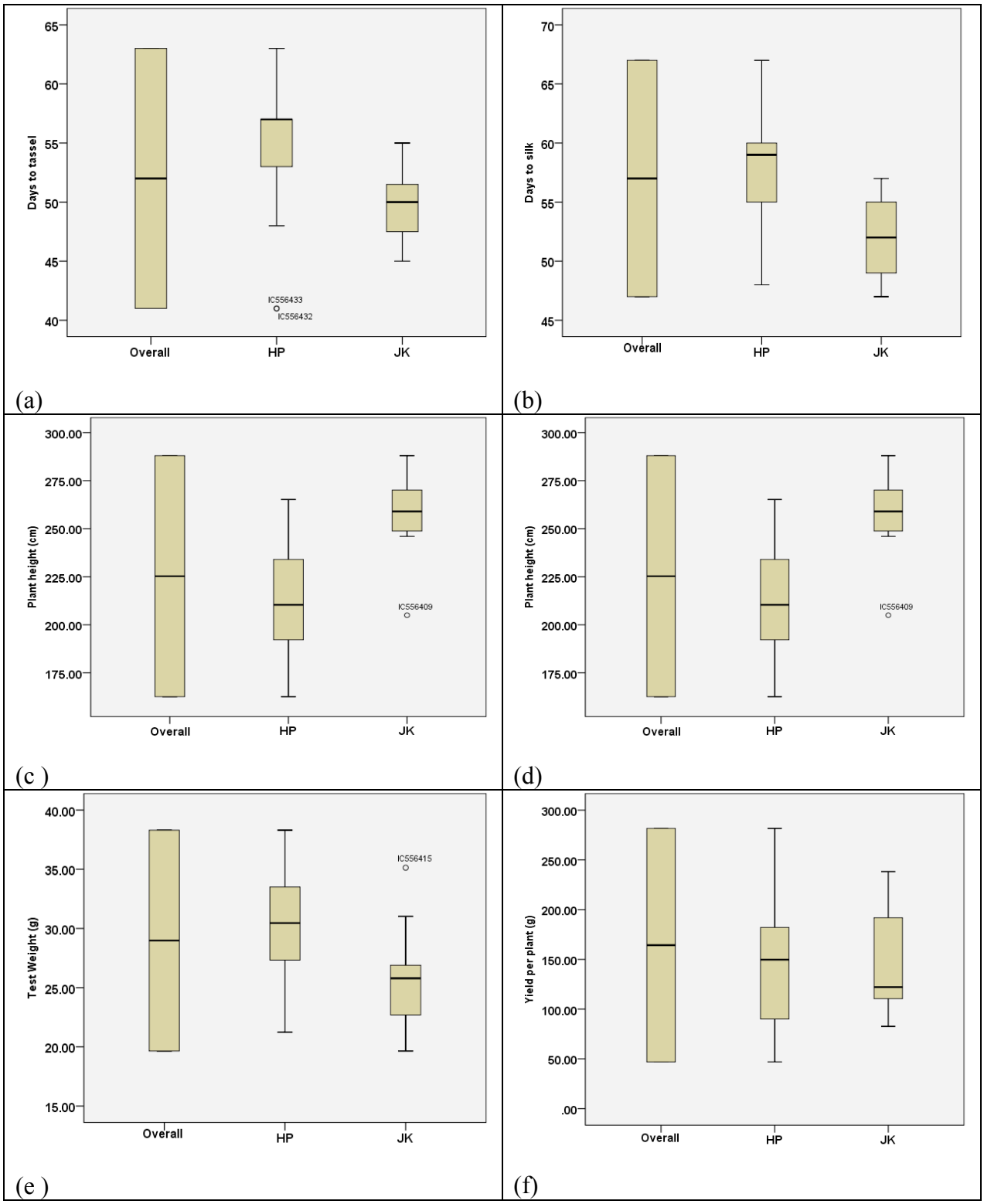

Fig 2 (a-f). Box plot showing variation in days to tassel, days to silk, plant height, ear height , test weight and yield per plant